

Analysis of 2009 NHTS for SCAG Region

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Using National Household Travel Survey Data
for Transportation Decision Making
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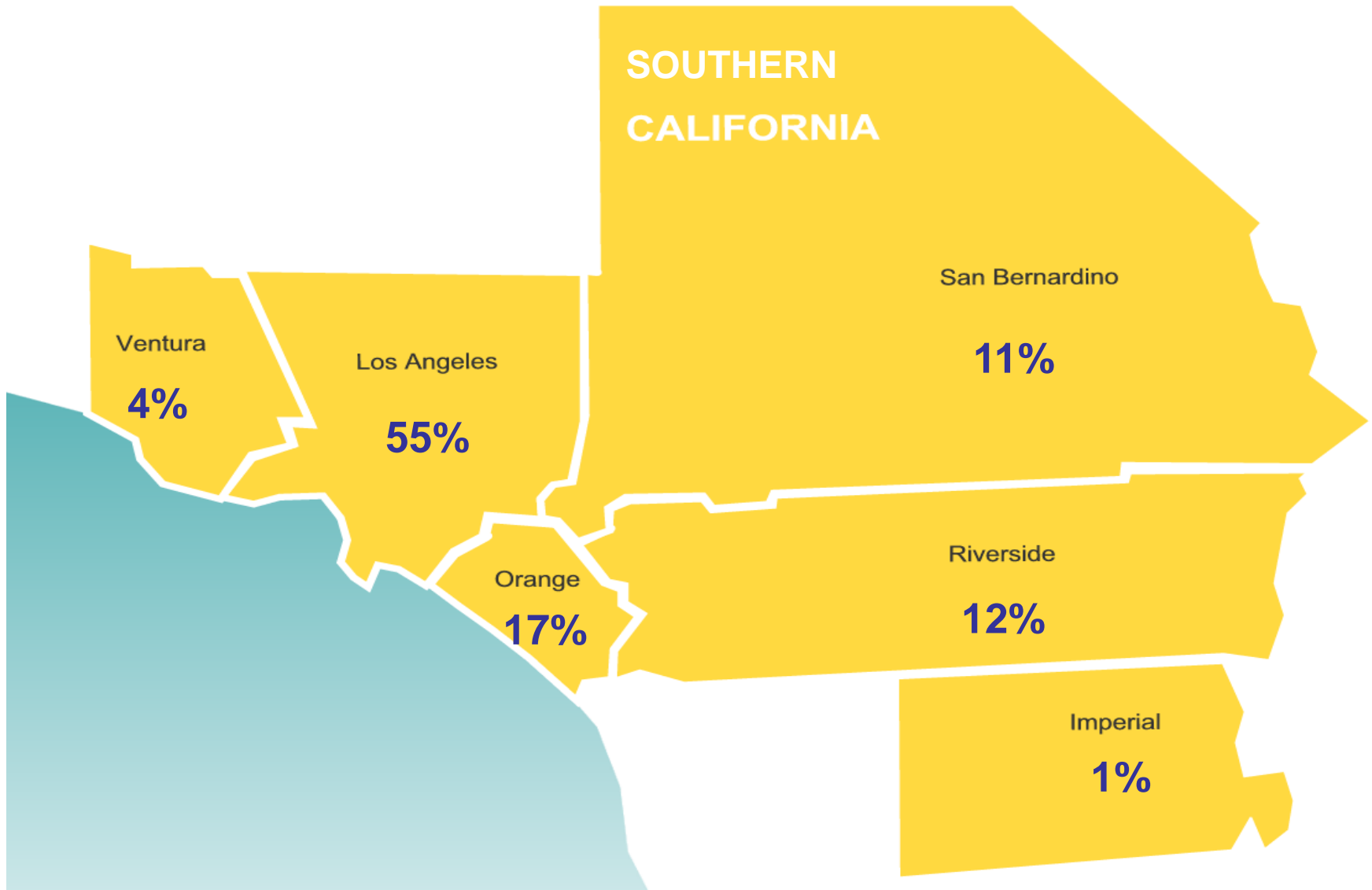
About SCAG Region

- SCAG
 - Southern California Association of Governments
 - A MPO in Southern California
- Six counties:
 - Los Angeles, Orange, Riverside, San Bernardino, Ventura, Imperial
- 18 million people, 6 million housings, and 8 million jobs
- About 6% of the US and half of California
- Los Angeles is the largest city

SCAG Region



SCAG Counties & Population Share



Travel and Demographics

- Travel characteristics of Southern California is generally characterized as prevalent use of freeways and automobiles
- SCAG region is also known by diversified demographics
 - High share of Hispanic population, geographic difference in income and racial distribution, new immigrants and their 2nd/3rd generation, and aging of baby boomer.
- Past research has shown the variance of travel pattern by demographic segments

Land Use Policy

- California Senate Bill No. 375 seeks to reduce greenhouse gas (GHG) emissions from more compact and efficient development.
- It is expected that the change in residential land use will reduce the reliance on auto use while encouraging the use of transit and non-motorized travel that will ultimately lead to GHG emissions reduction.
- SCAG is responsible for the development and analysis of SB 375 for the region.
- Does land use – travel behavior relation differ by demographic segments?

Objectives

Objectives of this study:

1. Provide updated travel data of SCAG region. The last travel survey was conducted during 2000-2001.
2. Analyze the relation of residential location and travel characteristics
 1. For total population
 2. By Hispanic status, immigration status, and income level
- Results of this study will be provided to SCAG planners and modelers for their analysis on transportation policy and planning.

About NHTS

- The National Household Travel Survey (NHTS) is a periodic national survey on travel and transportation patterns in the US. The NHTS serves as the nation's inventory of daily travel.
- The 2009 NHTS is the latest survey collected by Federal Highway Administration.
- Previous surveys included the 2001 NHTS, and the former surveys of 1969, 1977, 1983, 1990, and 1995.
- Data is collected on daily trips taken by households and individuals in those households, over a 24-hour period.

NHTS (continued)

- NHTS data are collected for all trips, modes, purposes, trip lengths, and all areas of the country, urban and rural.
- Uses of Surveys:
 - quantify travel behavior
 - analyze changes in travel characteristics over time
 - related travel behavior to the demographics of the travel, and
 - study the relationship of demographic and travel over time

2009 NHTS Add-On

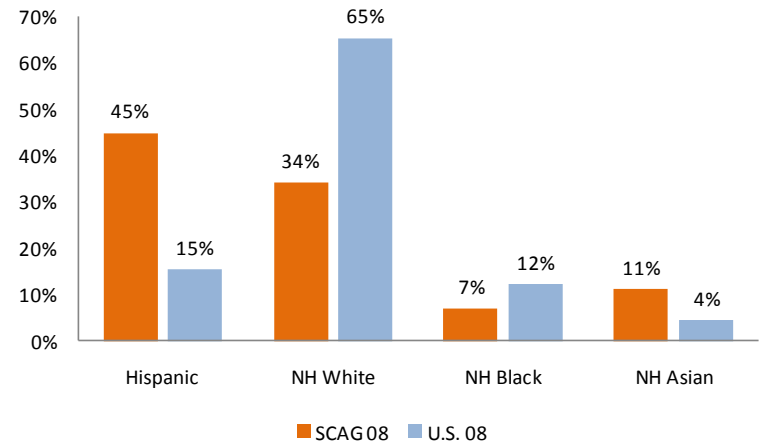
- We received 2009 NHTS California add-on data from Caltrans (CA DOT)
- With 6,700 household samples, 2009 NHTS provides valuable data and sufficient observations for us to analyze travel characteristics for SCAG region
- We created land use characteristics based on household latitude and longitude, SCAG growth forecast, and GIS database

SCAG Demographics & Personal Travel Characteristics

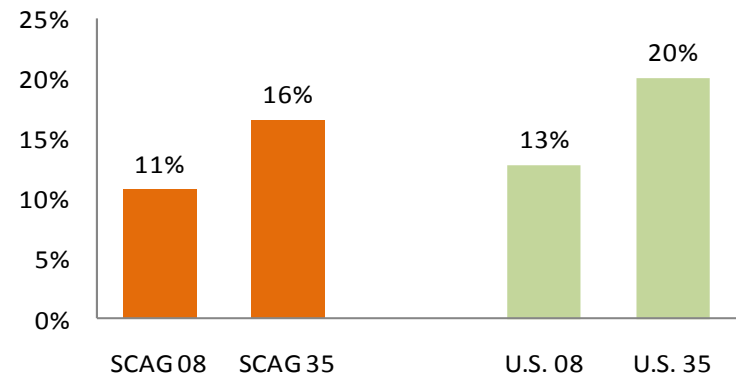
SCAG Population

- 18 million people in 2008
- 22 million in 2035
- 45% is Hispanic (15% US)
 - 53% in 2035
 - Future regional travel pattern will be affected by large % and increase of Hispanic population
- Aging trend of baby boomer is less significant at SCAG than in the US

Race/Ethnicity Distribution - 2008

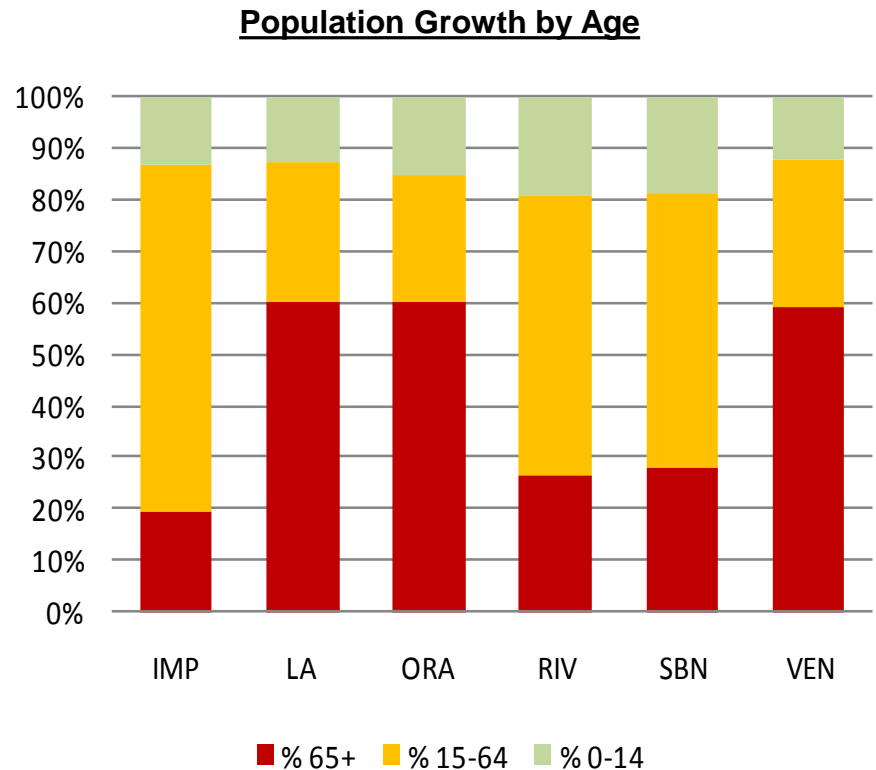


% & Growth of the Elderly (64+)



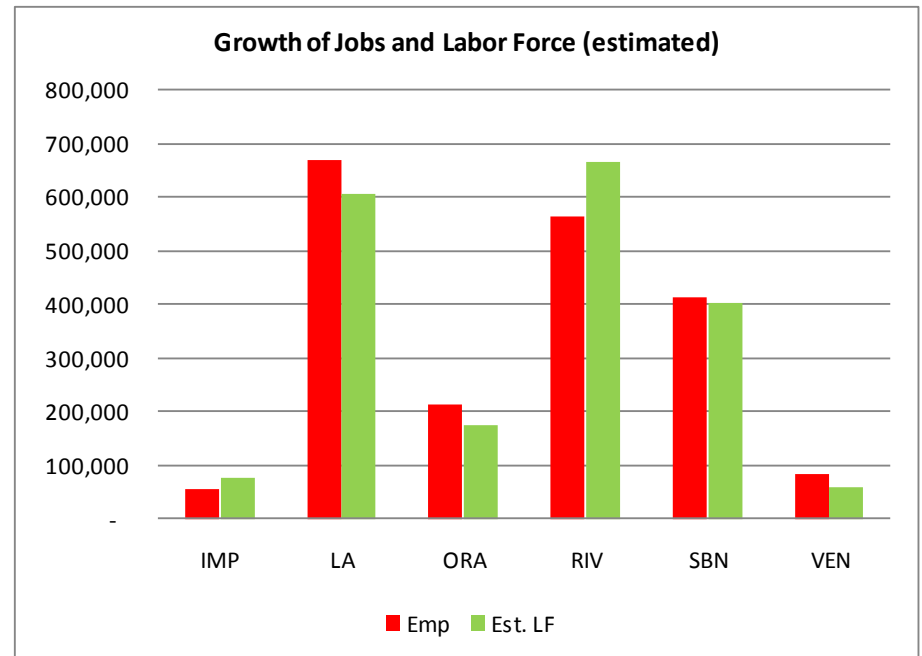
Population Growth

- Population will grow by 4 million between 2008-35
- 3 coastal counties have higher growth of elderly
- 3 Inland counties have higher growth of working-age population
- What kind of travel service should be provided to the elderly in coastal counties?
- More inter-county commuting from Inland?



Job Growth

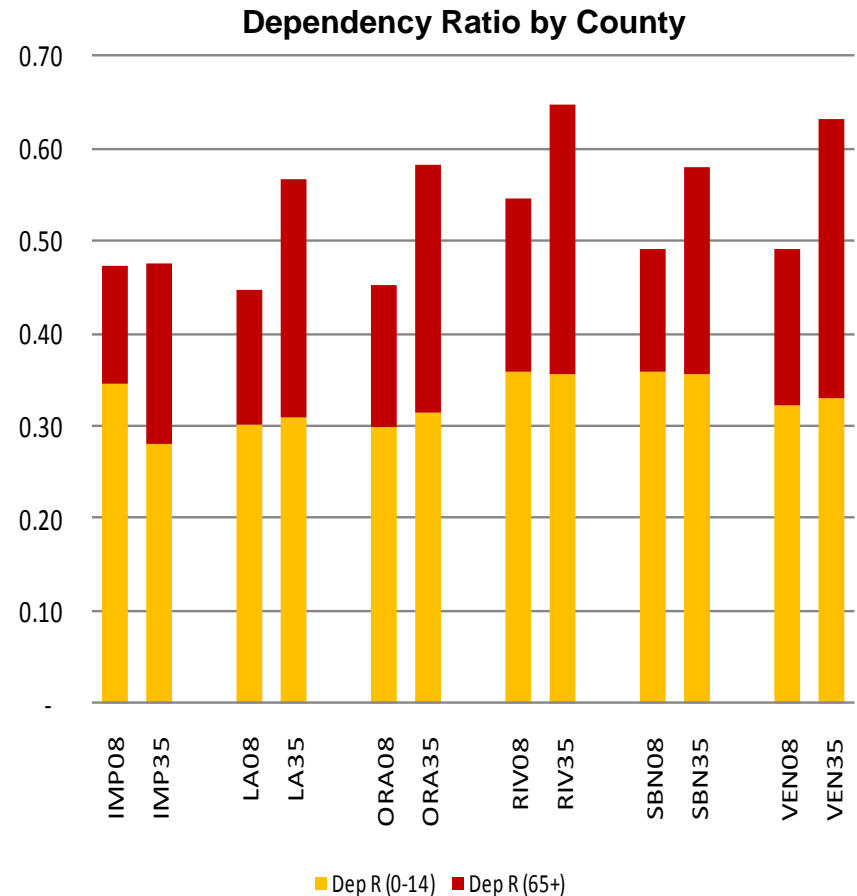
- More job growth than labor force growth in 3 coastal counties 2008-35
 - Need more workers from outside
- More inter-county or long distance commuting from Riverside County?
- Relocation of firms?



Assumption of LFPR: 15-24: 55%; 25-64: 88%; 65+: 30%

Dependency Ratio

- Between 2008 and 2035, SCAG Dependency Ratio will increase from 0.47 to 0.58
- More resources be allocated to social welfare? How will that influence on transportation finance?



Analysis of 2009 NHTS

- Our analysis focuses on
 - Person travel during weekdays
 - Trip distance < 200 miles (travel distance & VMT)

2009 NHTS Sample Size

	SCAG		US	
File	Samples	Weighted	Samples	Weighted
Households	6,663	5,462,021	156,567	118,896,799
Persons	14,536	16,268,531	308,901	283,053,872
Vehicles	13,798		309,163	
Travel Day Trip	54,555		1,167,321	
Persons wkday	10,409		220,574	

Weekday Person Travel

- Compared to the US, SCAG residents use less auto, but more on non-motorized and transit modes
- SCAG travel distance and VMT is shorter

		SCAG	US
Trips			
	Daily trips	3.8	3.9
	% no trip	11%	11%
Mode Share			
	Driver/Auto	56%	62%
	Passenger/Auto	21%	21%
	Non-motorized	17%	12%
	Transit	4%	2%
Distance			
	Daily distance	26	31
	Daily VMT	18	21

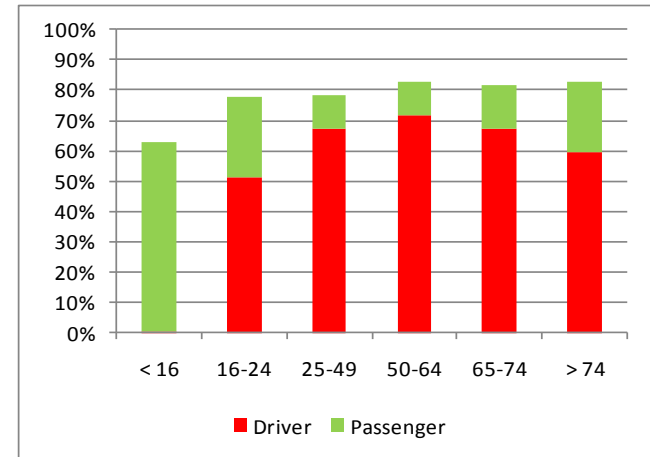
Travel by Age

- Travel decrease with older age
- The elderly rely on a car though driving less
- 1/3 of the 75+ did not travel on the survey day

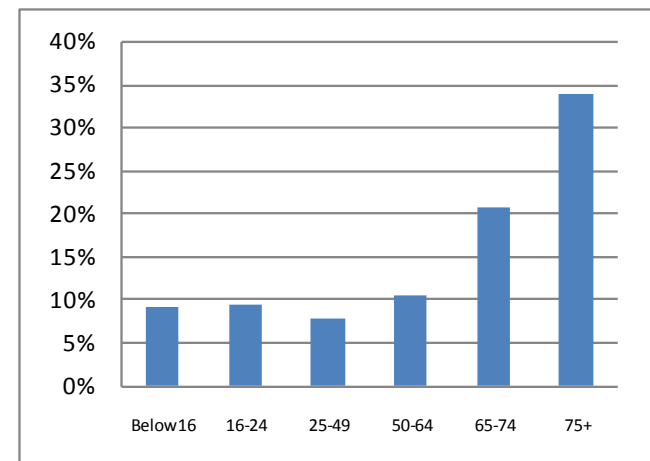
Daily Travel by Age

Age	Daily Trips	Daily Distance	% Auto Use
Below16	3.1	12	63%
16-24	3.5	25	78%
25-49	4.4	33	78%
50-64	4.0	31	83%
65-74	3.4	20	82%
75+	2.7	14	83%

Mode Share by Auto



% of persons did not travel on survey day



Travel by Age (2)

- The elderly wait for more days than younger for next trip
- When they travel, they travel no less trips than the younger for non-work purpose
- The elderly is active. They travel for participating activities and maintain their daily needs

Travel by Age

	# days since	<u>If traveled, # trips for</u>	
Age	last travel*	All Purpose	Non-work
Below16	3	3.4	3.4
16-24	2	3.9	3.3
25-49	3	4.7	3.9
50-64	3	4.5	3.6
65-74	4	4.3	4.0
75+	7	4.0	3.9

* Lastday:If the person didn't travel, what is the number of days since last trip

Travel by Race/Ethnicity

- Compared to other groups, Hispanic population drive less; use more non-motorized and transit modes.
- The low car/hhsize ratio of Hispanic means a car is less available to household members, which is consistent with higher passenger share
- What transportation policy should be considered due to continuing growth of Hispanic population?

Daily Travel by Race/Ethnicity

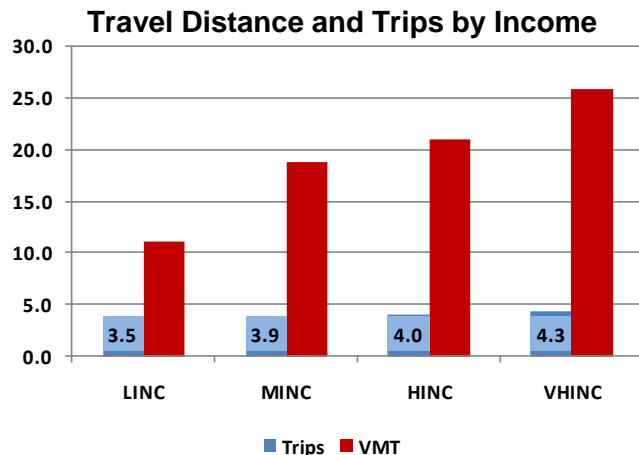
Race	Trips	Distance	Driver_Auto	Passngr_Auto	NM	Transit	Car/Hhsize
NH_WH	4.0	29	67%	18%	12%	1%	0.93
NH_BK	3.8	22	56%	20%	17%	5%	0.74
NH_AS	3.6	26	59%	23%	13%	2%	0.73
HISP	3.7	24	46%	24%	21%	6%	0.57

Household Income & Housing Types

- As expected, People with higher income travel more and drive more

Population Distribution by Income

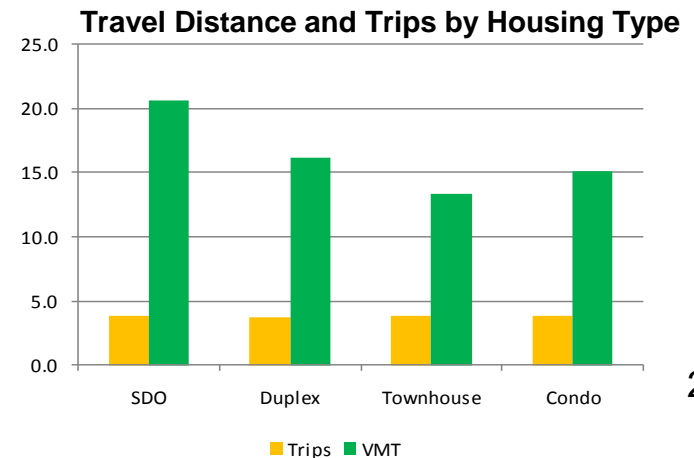
HHINC	Income	% person
Low	<30K	33.4
Medium	30-60K	22.3
High	60-100K	19.1
Very High	100K+	20.8



- Residents living in single-detached units tend to drive more than those living in multiple units

Population Distribution by Housing Type

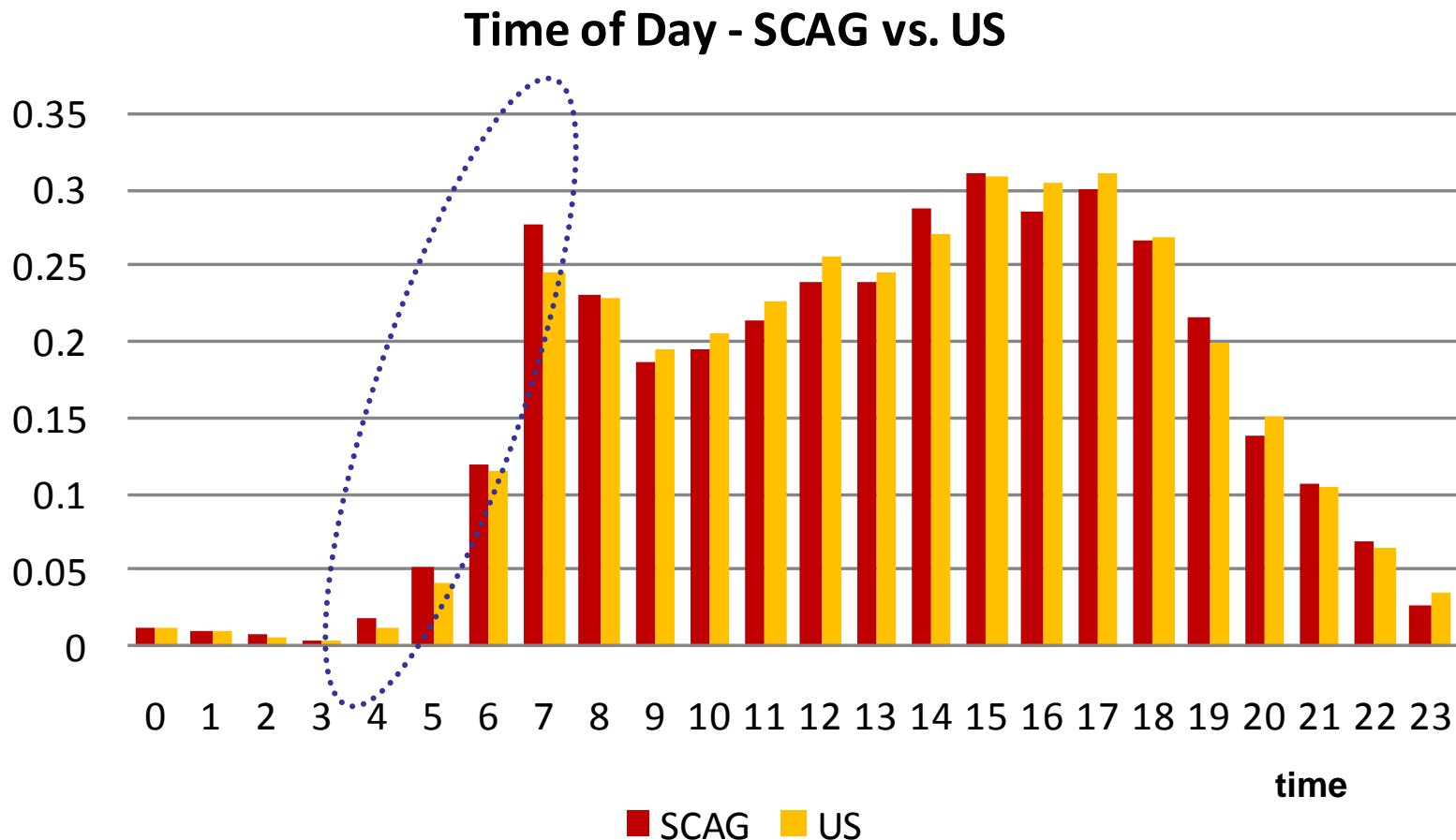
Housing Type	% person
Single, detached	61.2
Duplex	8.7
Rowhouse/townhouse	27.6
Apartment/condo	2.2



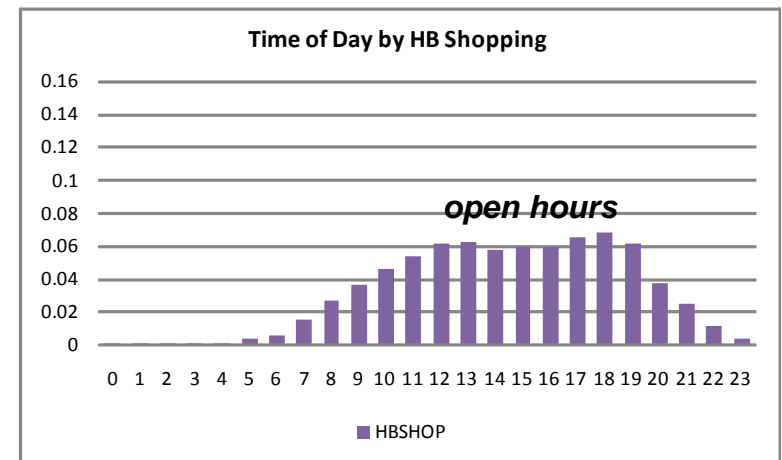
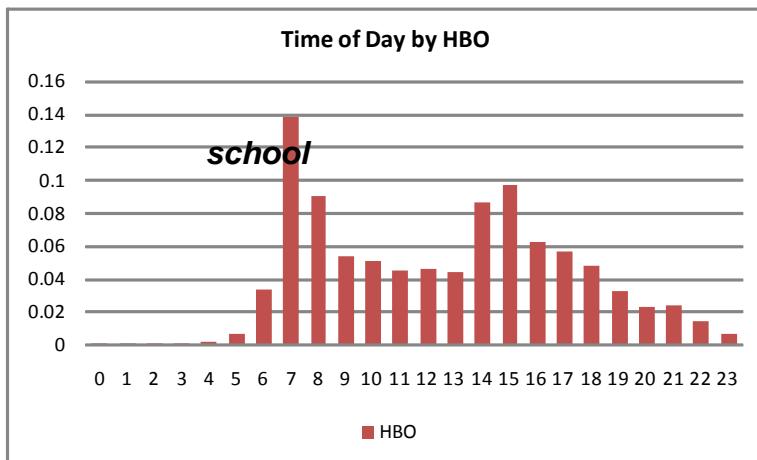
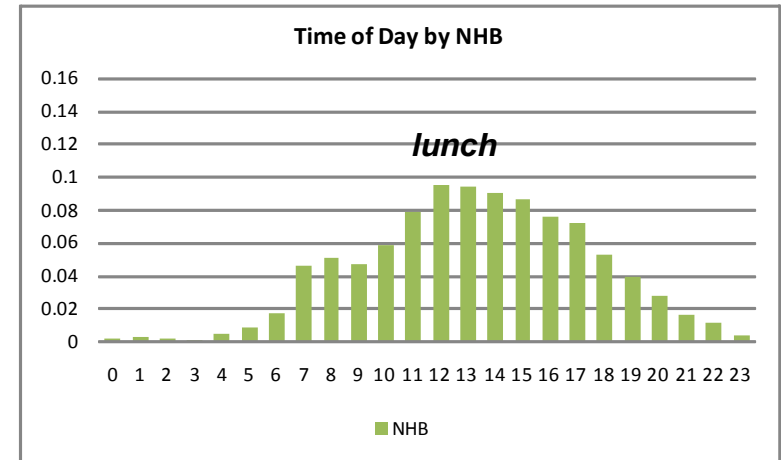
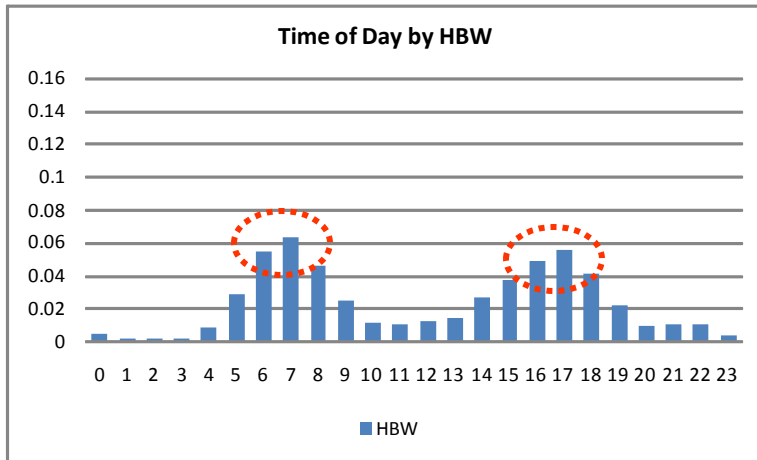
Time of Day

(% persons are traveling)

- SCAG region shows higher % from early morning to 8:00



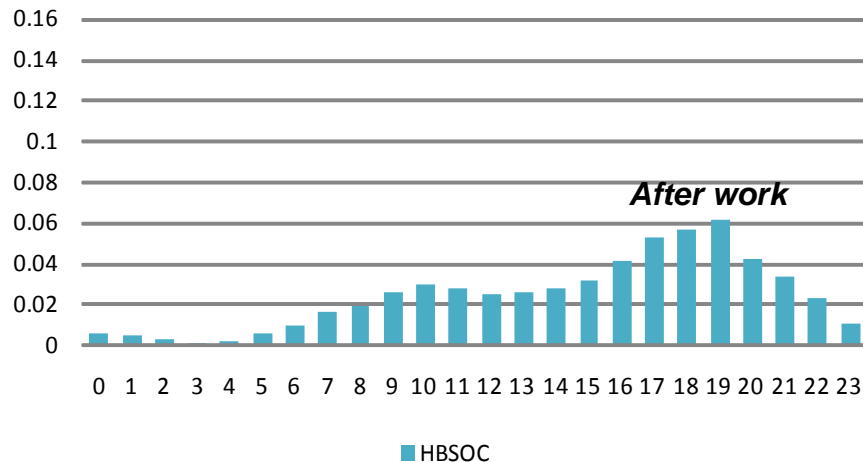
Time of Day by Purpose



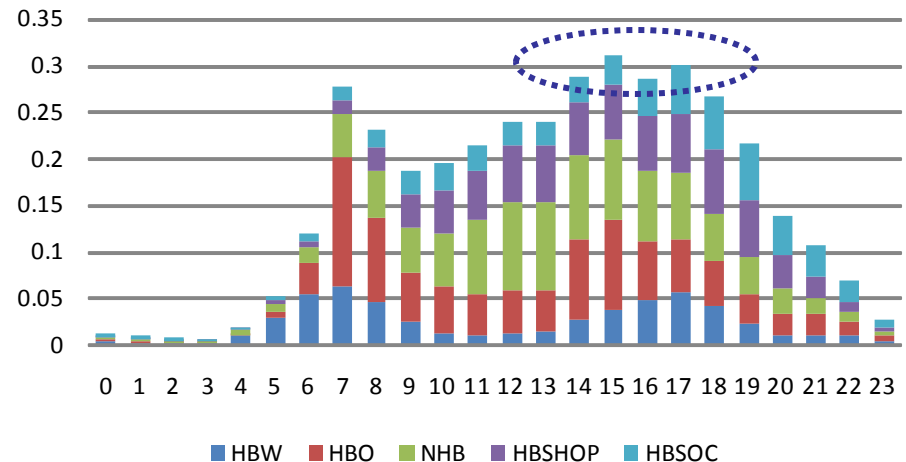
Time of Day by Purpose

- Afternoon peak happens during 14:00-18:00 due to travel demand for multiple activities
- High demand on travel in the afternoon

Time of Day HB Social/Recreation

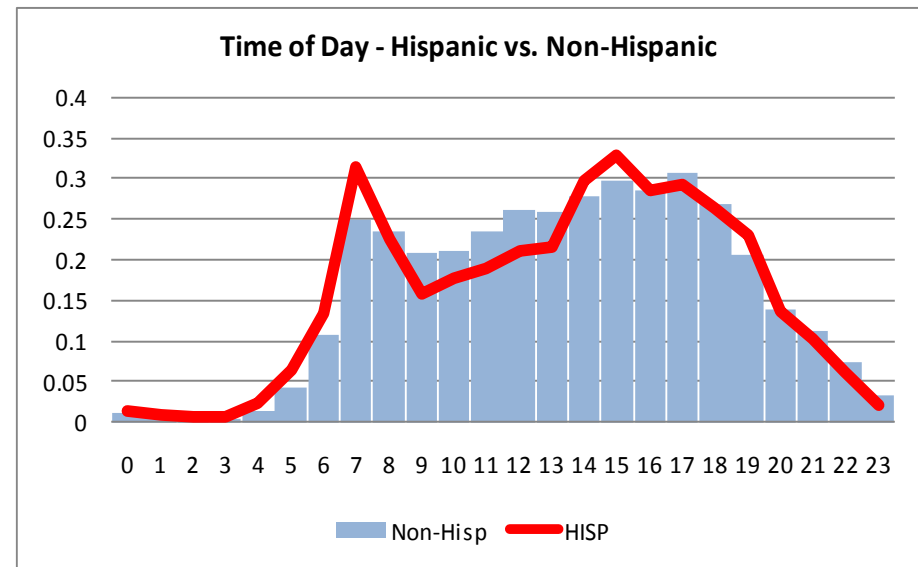
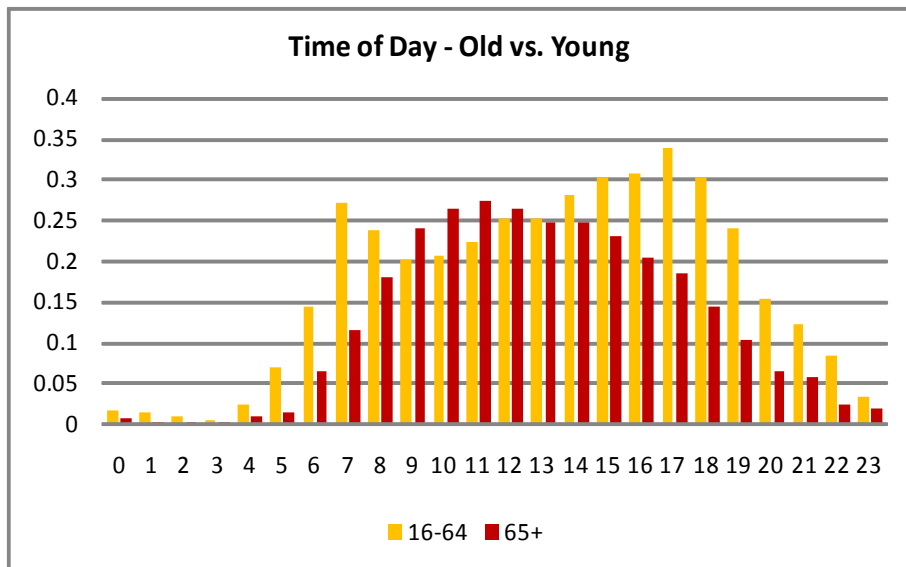


Time of Day by Purpose



Time of Day Elderly & Hispanic

- Peak travel period to the elderly is around noon
- More significant two peaks to Hispanic (7:00-8:00 and 15:00-16:00) than non-Hispanic



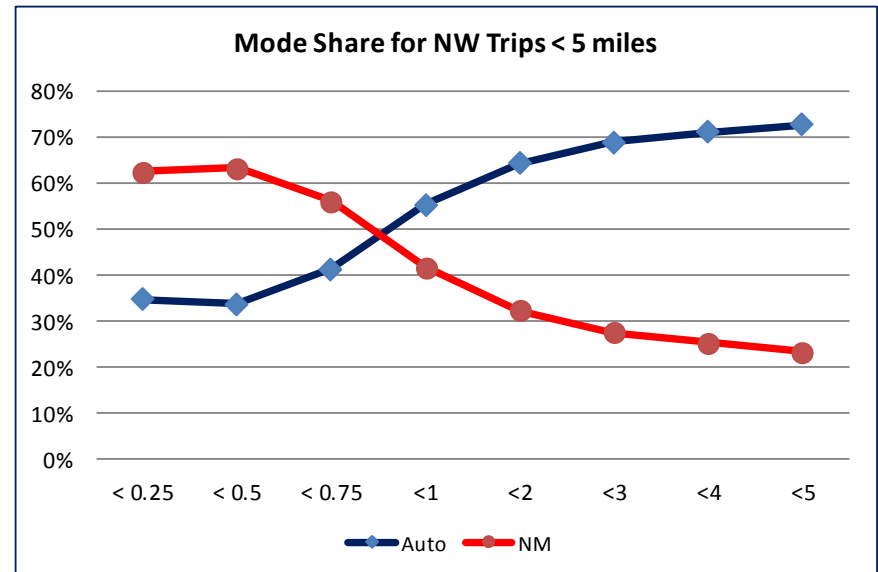
Trip Length

- Average trip length is 3 miles (median = 2 miles)
- Trip length is the shortest for home-based shopping (4.5 mi), and the longest is home-based work (12.8 mi)
- Non-motorized share is the highest for short travel less than 1 mile
- One approach to promote NM use is to increase neighborhood shopping opportunity

Trips Length by Purpose

TRIPPURP	%	Mean	Median
HBO	25.0	6.1	2
HBSHOP	21.9	4.5	2
HBSOCREC	14.5	8.6	3
HBW	11.3	12.8	8
NHB	27.1	7.5	3
ALL		7.3	3

* trip length >0 and <=200, all days



Land Use and Travel

Land Use Policy

- California Senate Bill No. 375 seeks to reduce greenhouse gas (GHG) emissions from more compact and efficient development.
- It is expected that the change in residential land use will reduce the reliance on auto use while encouraging the use of transit and non-motorized travel that will ultimately lead to GHG emissions reduction.
- SCAG is responsible for the development and analysis of SB 375 for the region.

Question

- Travel behavior theory recognized that daily travel choices are related to choices about residential location, job location, and auto ownership.
- Land use policy, such as SB 375, based on the concept of residential location - daily travel relation, is suggested to reduce problems caused by auto use, including congestion, air pollution, and GHG emissions.
- Does this residential location - daily travel relation work for people with different demographic background?
- We use NHTS to examine the relation between residential land use characteristics, distance to work, and mode for commute

Residential Land Use

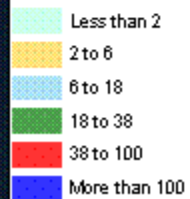
- Residential land use characteristics of neighborhoods:
 - Residential density (housing units per acre)
 - Local service accessibility (employee per acre)
 - local service = retail + other service + business service + finance + accommodation/food
- Use SCAG TAZ zones as neighborhoods
 - 11,268 zones, based on Census block group

Residential Density

Downtown LA

LAX

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Local Service Accessibility

Downtown LA

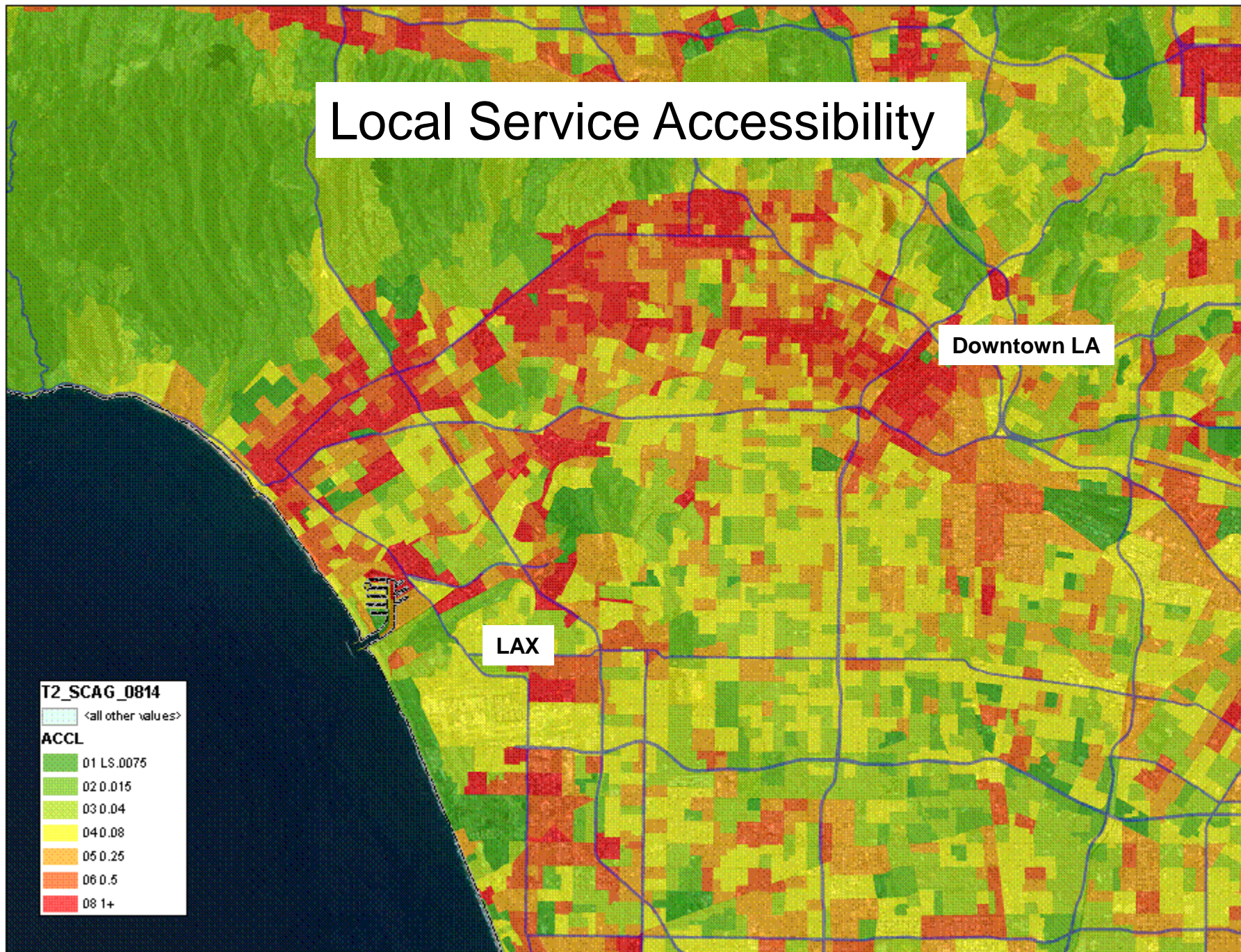
LAX

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ACCL

- 01 LS.0075
- 02 0.015
- 03 0.04
- 04 0.08
- 05 0.25
- 06 0.5
- 08 1+



Residential Density

- Assumed less vehicle use and more walking with higher residential density
- Residential density:
 - housing units/residential area of each SCAG TAZ
 - 2008 housing units: SCAG estimate
 - Residential area: parcel residential land use within TAZ
- Six density categories are created:
 - ≤ 2 ; 2-6; 6-18; 18-38; 38-100; and 100+

Population Distribution by Residential Density

- 54% of SCAG population live in medium density neighborhoods (6-18 units/acre)
- About 20% each in low density (2-6) and high density (18-100)
- Hispanic residents tend to live in medium-high density neighborhoods; White tends to live in low-medium density

Population Distribution by Residential Density								
Density (units/acre)		% person	NH-W	NH-B	NH-A	NH-Ind	HISP	NH-O
<2	Low	4%	6%	0%	3%	2%	2%	4%
2-6	Low	22%	31%	9%	23%	22%	16%	23%
6-18	Medium	54%	49%	68%	59%	55%	59%	47%
18-38	High	14%	9%	15%	12%	16%	16%	16%
38-100	High	5%	4%	4%	2%	6%	5%	6%
100+	V High	1%	1%	3%	1%	0%	2%	5%

Daily Travel by Residential Density

- Pattern is clear and as expected
- Higher density → lower % driving a car, higher % non-motorized and transit modes, shorter travel distance and VMT
- Daily trips are about the same, except for “38-100”
 - probably due high % of single-person households

Daily Travel by Density

Density	Weekday Travel		Mode Share		NM	Transit	Daily		% Single
	trip	notrip	Driver	Passngr			Dist	VMT	
<2	3.7	15%	66%	24%	6%	1%	38	28	5.8
2-6	3.8	11%	64%	22%	10%	1%	30	22	5.6
6-18	3.8	11%	57%	21%	16%	3%	25	17	7.6
18-38	3.8	9%	46%	18%	25%	8%	22	14	11.2
38-100	4.3	11%	41%	19%	27%	10%	22	13	16.9
100+	3.7	10%	39%	18%	29%	12%	18	9	11.0

Daily Travel by Local Service Accessibility

- Similar to residential density, residents living in areas with higher local service accessibility tend to less driving a car, more using non-motorized and transit modes, and traveling for shorter distance and VMT

Daily Travel by Local Service Accessibility

Local Acc	% person	Weekday Travel		Mode Share		NM	Transit	Daily Dist	VMT
		trip	notrip	Driver	Passngr				
<0.01	10	3.8	11%	63%	23%	10%	1%	33.7	24.4
0.01-0.15	16	3.7	11%	62%	22%	12%	2%	29.9	21.7
0.15-0.6	25	3.9	11%	55%	23%	16%	3%	25.0	17.3
0.6-1.8	26	3.7	12%	55%	19%	18%	5%	22.6	16.1
1.8-4	14	3.9	8%	52%	20%	20%	5%	24.3	16.6
4-10	6	3.6	14%	51%	19%	22%	6%	25.5	15.7
>=10	2	4.5	6%	50%	15%	29%	4%	17.2	11.8

Density & Accessibility

- Residential density and local service accessibility are somehow correlated.
- Accessibility level can be very different to the same level of density
- The combination of the two can be used to describe the level of mixed land use

% Households (of each density) by Local Service Accessibility

Den\Acc	<0.01	0.01-0.15	0.15-0.6	0.6-1.8	1.8-4	4-10	>=10
<2	42.23	38.68	11.17	6.55	1.37	0	0
2-6	16.97	38.17	26.99	12.54	4.34	0.53	0.46
6-18	7.28	11.36	30.2	32.16	14.54	3.84	0.62
18-38	0.19	1.5	9.35	36.01	28.4	18.13	6.42
38-100	1.66	1.24	6.59	13.45	27.16	31.8	18.11
100+	3.22	2.68	14.11	22.24	11.67	24.73	21.35

Residential Location and Commuting

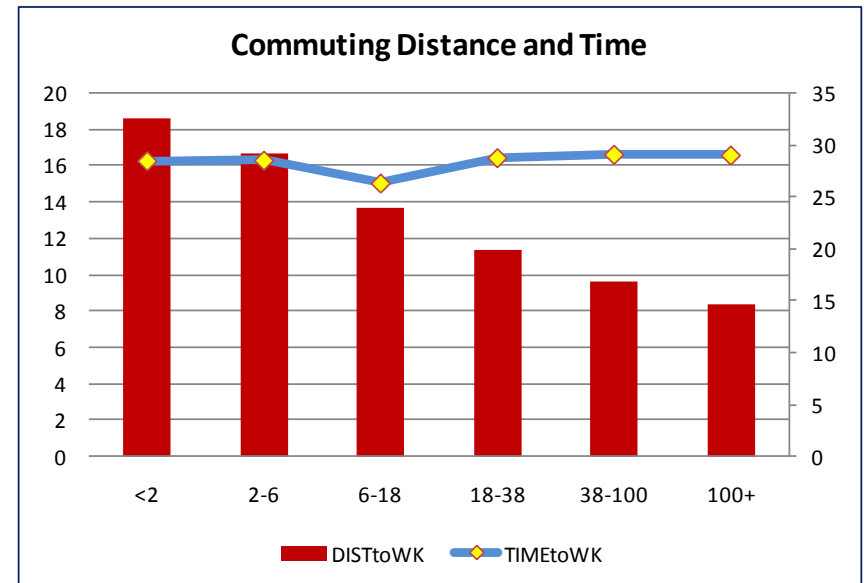
- Examine characteristics of long-term residential location choice for SCAG region, including:
 1. Residential Location
 - residential density, housing type, level of transit services (# transit stops/area)
 2. Commuting
 - Distance to work, time to work, mode
 3. Demographics
 - Total population, Hispanic, immigrants

Residential Density & Commuting Distance

- Households in lower density neighborhoods:
 - higher % of single family
 - Most have at least one car
- People living in higher density neighborhoods:
 - shorter commuting distance
 - work location closer to home
- Commuting time is about the same for different density
- Closeness of work location to home is associated with high residential density

Household Characteristics and Commuting

Res Density	Households		Workers	
	% SDO	% No car	DISTtoWK	TIMEtoWK
<2	89	2	19	28
2-6	85	2	17	29
6-18	59	8	14	26
18-38	22	15	11	29
38-100	11	18	10	29
100+	4	38	8	29



Residential Density & Commuting Mode

- Households in higher density neighborhoods:
 - cars are less available to household members
 - transit services are more available
 - more likely to commute by transit and non-motorized modes, less likely by auto

Commuting Mode by Density

Residential		Transit	<u>% Commuting Mode</u>		
Density	Car/Hhsize	Density	Auto	Transit	NM
<2	0.9	0.0	93	2	1
2-6	0.8	0.0	91	2	2
6-18	0.6	0.1	88	4	3
18-38	0.5	0.3	82	10	5
38-100	0.5	0.5	78	12	6
100+	0.3	1.2	63	19	14

- Workers in high-density neighborhoods are less likely to commute by a car; more likely by transit and non-motorized modes
- Results are as expected

Hispanic - Commuting Distance

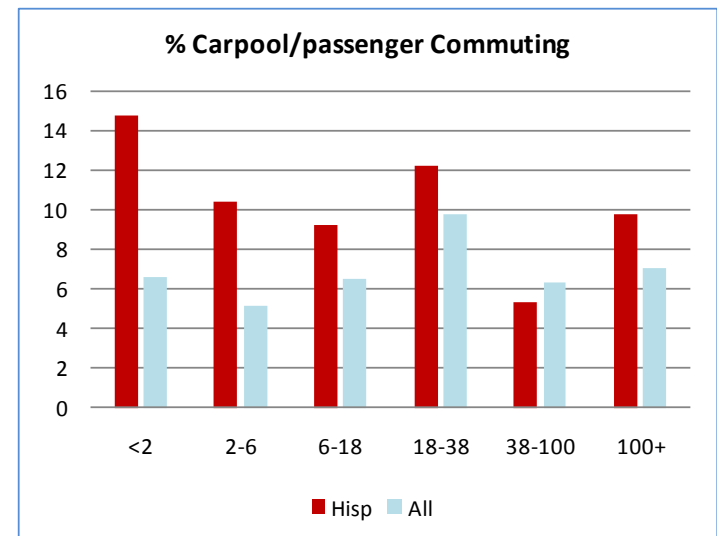
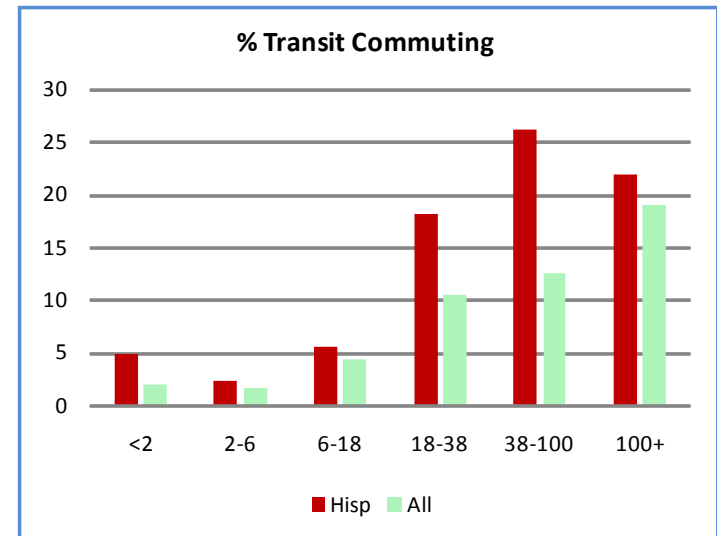
- Compared to total population,
 - Hispanic households living in lower density neighborhoods are shown lower % of living in a single-family house
 - Cars are less available than total population
- Commuting distance also decreases with density, but
 - Hispanic workers living in very low-density neighborhoods (<2) travel much shorter distance to work (12 mi) than total population (19 mi)

Household Characteristics and Commuting

	Households				
Res Density	% SDO	Car/Hhsize	% No car	DISTtoWK	TIMEtoWK
<2	75	0.7	5	12	22
2-6	79	0.6	2	19	31
6-18	57	0.5	13	13	27
18-38	23	0.4	18	12	31
38-100	11	0.3	29	10	33
100+	0	0.2	49	7	27

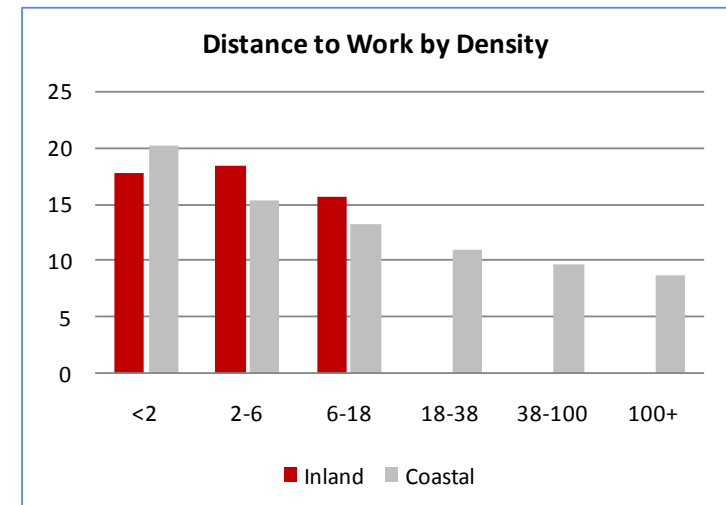
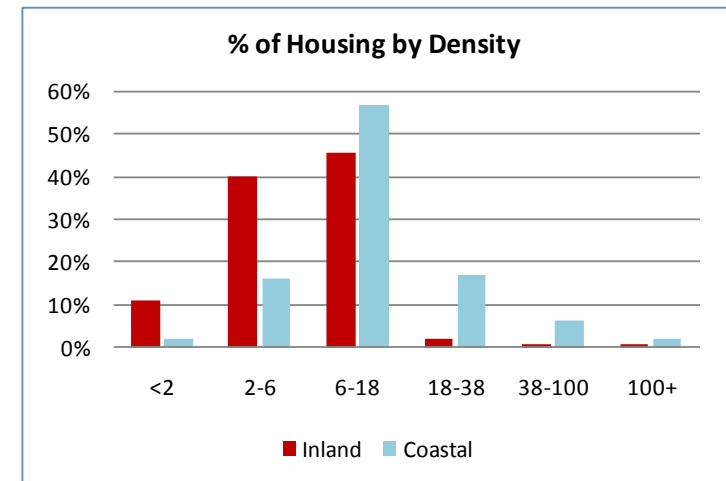
Hispanic - Commuting Mode

- A car is the still major commuting mode to Hispanic workers living in lower density neighborhoods
- Compared to total population,
 - Hispanic commuters have higher % transit commute, especially in high-density areas
 - They also have higher % of carpool commute, especially in low-density areas



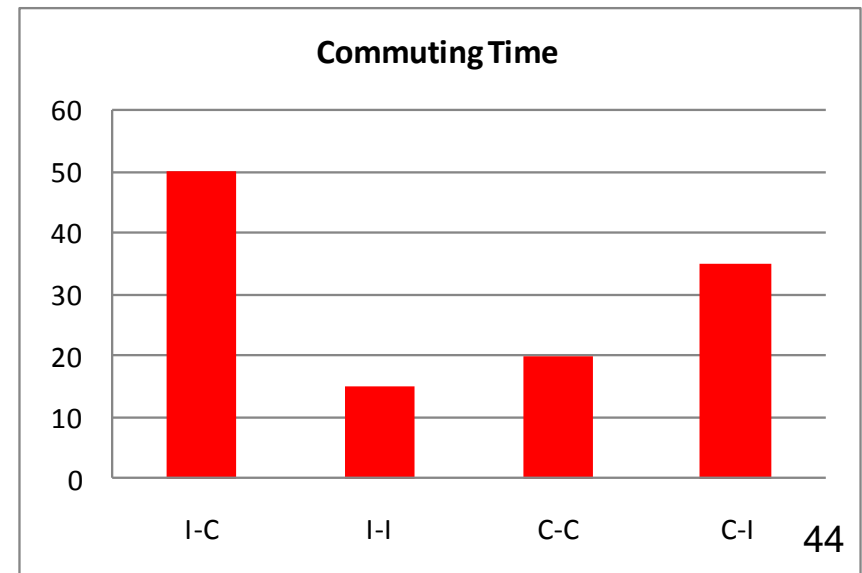
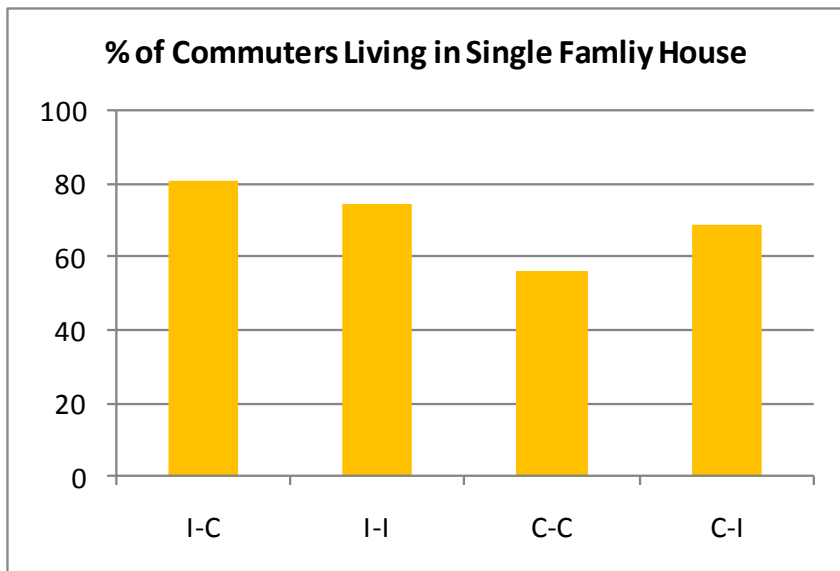
Residential-Commuting in Inland Counties

- About 300,000 workers living in Inland counties commute long distance to Coastal counties. What is their decision to residential-work location?
- Inland neighborhoods are primarily low-median density. 95% of households are in low-med density areas. One reason for people chose to live in this areas
- Most Inland households have at least one car, and the car is the major commuting mode
- Mean commuting distance is 15 mi+
- People choosing to live in this areas is probably due to their preference to low-density living environment



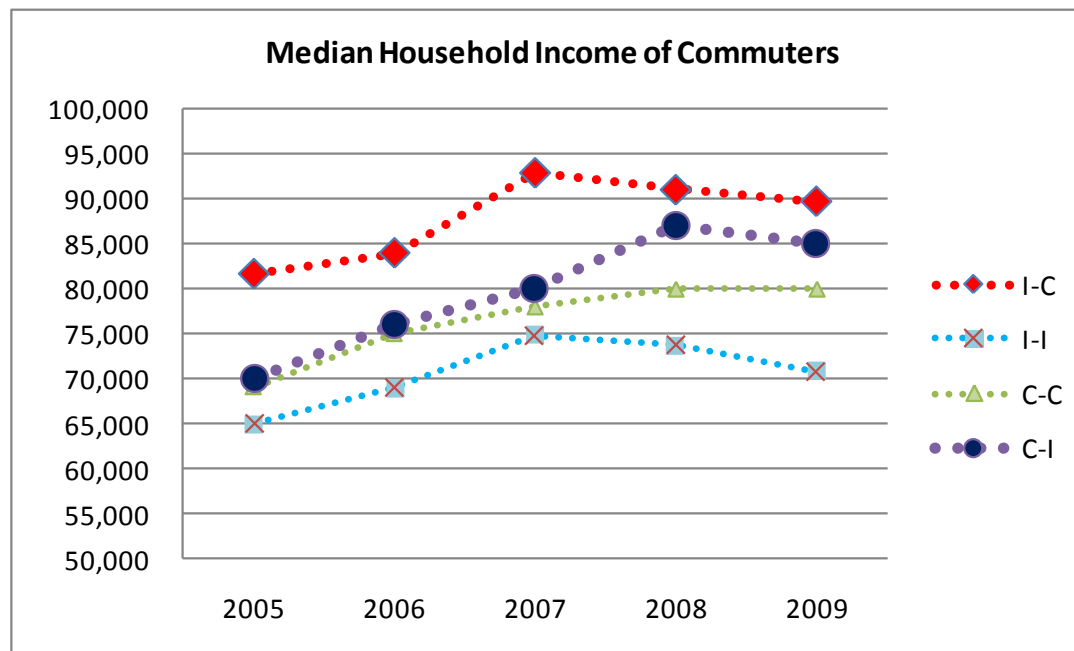
Residential-Commuting in Inland Counties (2009 ACS)

- According to 2009 ACS, 80% of commuters from Inland to Coastal counties (I-C in the chart) live in a single family house
- Their median commuting time is 50 minutes. 97% commute by cars, and about 2% by commuter rail (Metrolink)
- Given long commuting time, those people have strong preference to their residential location choice.



Residential-Commuting in Inland Counties (2009 ACS)

- Median household income of inter-county commuters are higher than other commuters
- Coastal counties will need more labor forces from outside counties in the future (discussed earlier), what is the strategy to resolve the impact of very long distance vehicle commute?
- Policy implication on VMT fees?



Residential Location & Commuting of Immigrants

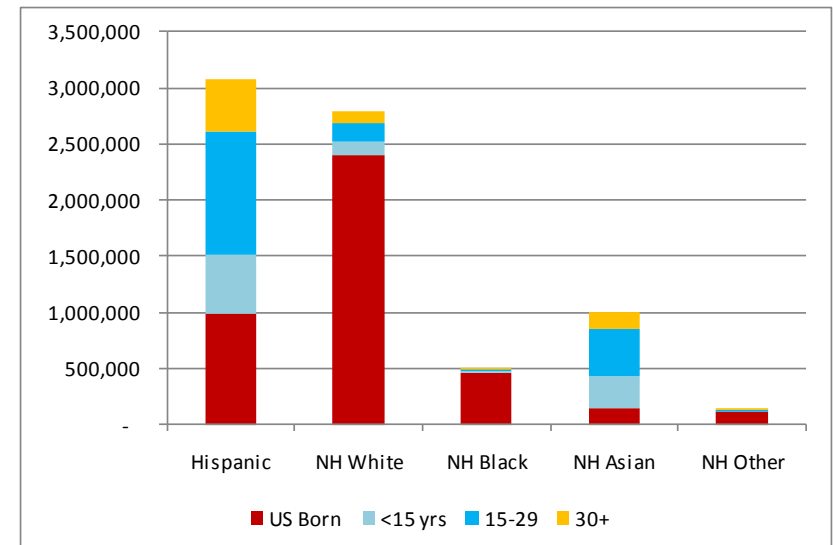
- Each year, many immigrants move to Southern California
- Will immigrants change (or assimilate) their behavior after years living in this region?
- The objective is to analyze the difference between newer immigrants, long-term immigrants, and the US born, in terms of their residential location-housing-travel relation.
- Targets on adults between 30-60 years old – they are primary decision makers of their family.
- By three race/ethnicity groups: Hispanic, Non-Hispanic White, and others. This study focuses on Hispanic population, due to larger share to total population

Immigrants Aged 30-60 Years Old (2009 ACS)

- 2008 ACS shows that 45% of aged 30-60 are immigrants
- 2/3 of Hispanic aged 30-60 are immigrants
- About half of Hispanic aged 30-60 are immigrants who entered US < 30 years
- Will high % of Hispanic population be continued in the future?
- Is travel behavior of newer immigrants same as the US born?

% Total pop 30-60 yrs old (SCAG Region)			
	Total	US Born	Immigrants
Hispanic	41%	13%	28%
NH White	37%	32%	5%
NH Black	7%	6%	1%
NH Asian	13%	2%	11%
NH Other	2%	1%	0%
Total	100%	55%	45%

Persons aged 30-60, by immigration status



NHTS Person Sample

- About 2000 sample persons from NHTS are foreign born and aged between 30 and 60 years old
 - % weighted persons: HISP 68%, White 13%, and Asian 16%
 - Overall, NHTS is consistent with ACS

<u>Data sample: age 30-60, immigrant to US</u>				
	sample	weighted	%	% 2008 ACS
NH_WH	439	389,858	13%	11%
NH_BK	19	27,732	1%	1%
NH_AS	435	499,468	16%	25%
NH_NA	1	3,291		
HISP	915	2,120,865	68%	62%
Other	47	57,131	2%	
Total		3,098,345		3,409,389

NHTS Person Sample (2)

- Below shows NHTS persons between 30-60 years old, by three race groups, and by four immigration status categories (entered US less than 15 years, 16-30 years, > 30 years, and US born)

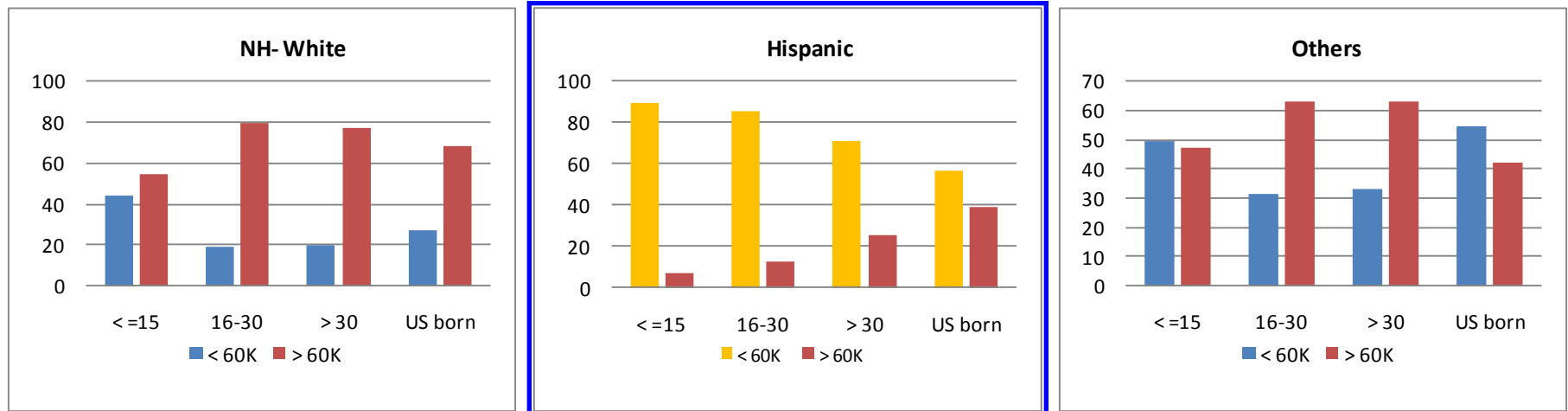
NHTS sample

Years in US	Race	sample #	%	Weighted	%
< =15	NH-W	103	2	125,656	2
16-30	NH-W	153	2	127,281	2
> 30	NH-W	173	3	130,002	2
US born	NH-W	3433	52	2,626,287	34
< = 15	HISP	227	3	691,407	9
16-30	HISP	408	6	939,008	12
> 30	HISP	261	4	438,825	6
US born	HISP	728	11	1,200,919	16
< =15	Other	131	2	221,591	3
16-30	Other	227	3	243,234	3
> 30	Other	137	2	111,180	1
US born	Other	575	9	846,237	11
SUM		6556	100	7,701,625	100

Household Income

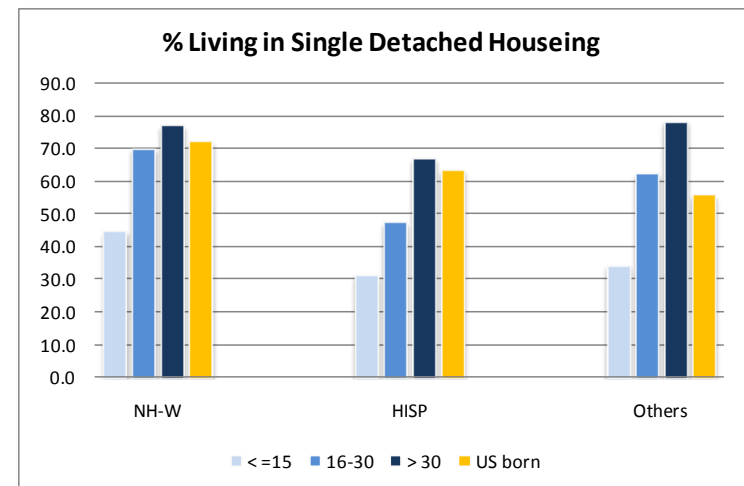
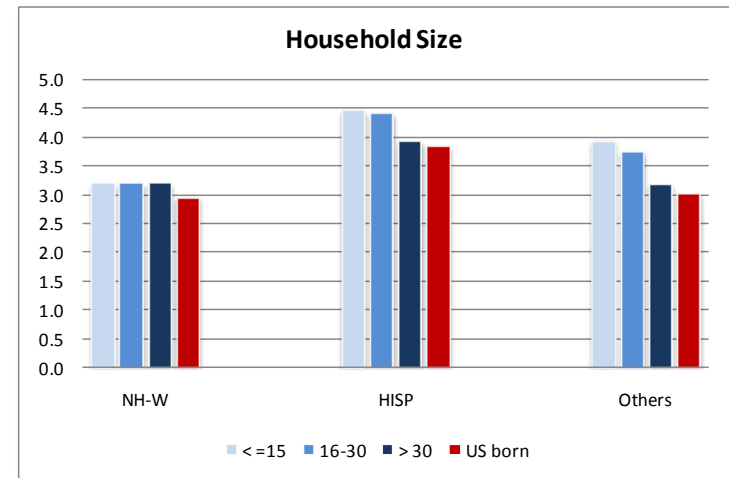
- Hispanic Immigrants show that income status is improved while staying longer in the US
- Non-Hispanic: Income is the higher for immigrants entered US > 15 years than those US born

Household Income by Immigration Status



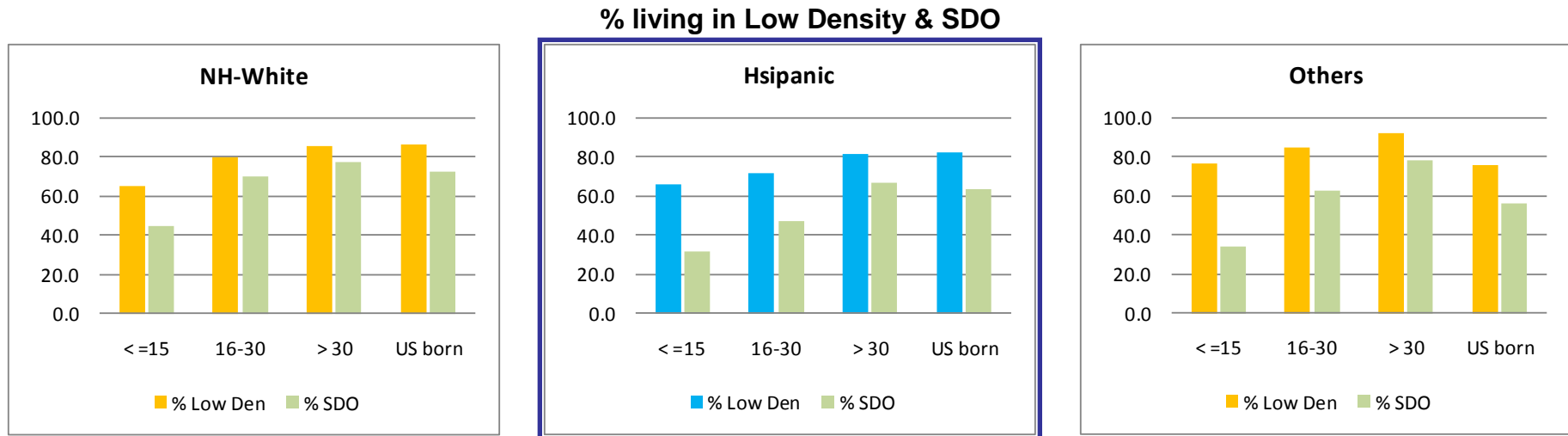
Household Size & Housing Type

- Longer-term immigrants show reduction of household size.
- Most newer immigrants live in multiple-unit housing. As they stay longer in the US, more of them live in a single family house, similar to the US born.
- Newer immigrants shows different household characteristics – income, size and housing type



Residential Density

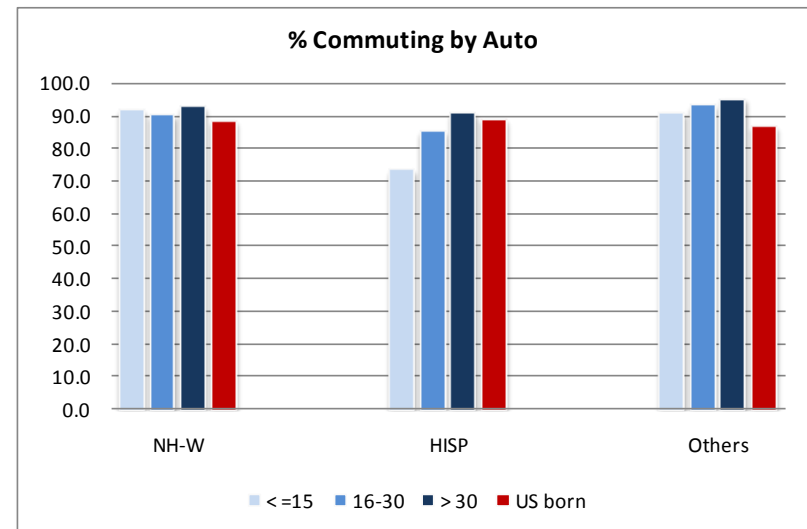
- Longer-term immigrants and US born tend to live in lower-density neighborhoods, similar to their pattern to live in a single family house
- How does immigrants' change on residential choice affect their travel choice? Are they going to use more car and drive more?



Commuting Distance and Mode

- Long-term Hispanic immigrants show 4 miles (and 33%) commuting distance increase, compared to new immigrants.
- In addition, as Hispanic immigrants entered US longer, they tend to use a car as commuting mode. The auto share for long-term immigrants is even higher than the US born

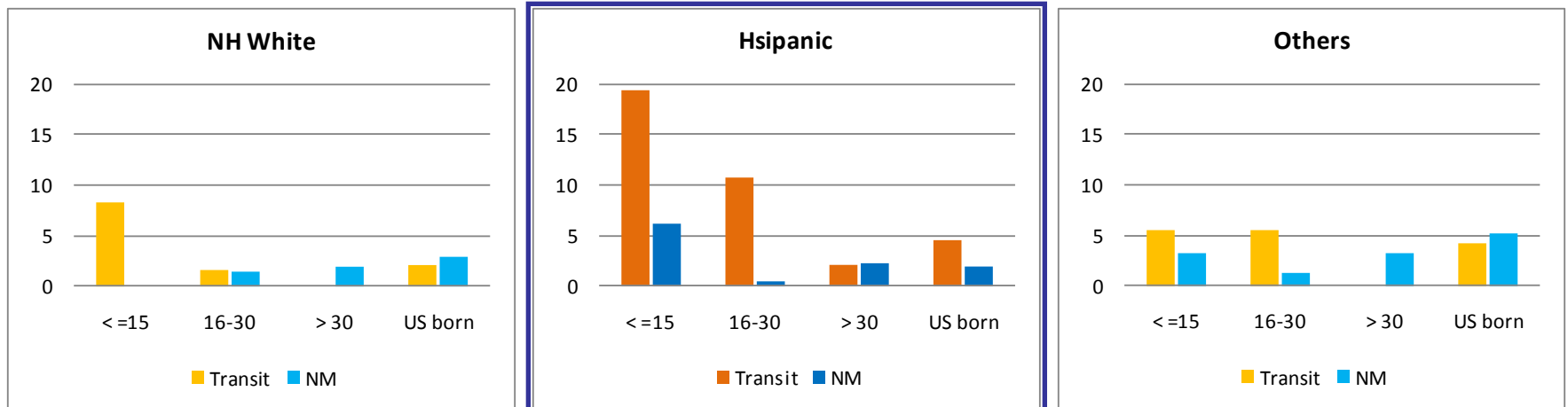
Distance to Work			
Years in US	NH-W	HISP	Others
< =15	14	12	13
16-30	16	14	13
> 30	18	16	15
US born	17	16	14



Commuting Mode

- The use of transit significantly drop as Hispanic immigrants entered US longer.
- For those US born, mode use among race/ethnicity for commuting purpose is close to each other.

Share of Transit and Non-motorized



Summary

- As Hispanic immigrants stay longer in the US, their income status is improved, and they tend to live in a single-family house within a lower-density neighborhood, just similar to the US born
- They commute longer distance, drive more and use less transit.
- If future proportion of immigrants is very different from current figure, how will that influence our travel forecast?

Interaction of Income and Residential Location on Daily Travel

Introduction

- Many studies have recognized that daily travel choices are related to choices of residential location, housing type, job location, auto ownership, and commuting mode.
- Land use policy, based on the concept of the interdependence of residential location choice with daily travel decision, is suggested to policy makers as a strategy to reduce problems caused by auto use.
- Briefly speaking, living in higher density areas is associated with less car use. However, it is also known that richer people generally drive more. What will happen if richer people living in high-density neighborhoods? Does influence of land use density outweighs income on vehicle use?

Objective

- Neighborhood quality, such as safety, design of sidewalks and streets, is believed to influence on people's travel choice, especially on walking or biking within their neighborhood.
- Except for representing residents' income level of a neighborhood, neighborhood median household income is also used for representing neighborhood quality. Assumed that wealthier neighborhoods have more resources to maintain safety, improve design, and enhance quality of infrastructure than poorer neighborhoods.
- This study is try to understand following two questions:
 1. Will people living in higher-income and higher-density neighborhoods drive more due to higher income, or drive less due to higher density?
 2. Will people living in lower-income neighborhoods use less non-motorized modes?

Neighborhood Density & Income

- The approach of this study is to analyze travel behavior of neighborhood residents by neighborhood density and by median household income
- Neighborhood geography is based on SCAG TAZs (11K). Total 12 categories are created (6 density x 2 income).
 - 5 land use density categories: <6, 6-10, 10-18, 18-38, 38+
 - 2 levels of median household income: \leq \$40K (low), $>$ \$40K (medium-high)

% Hhold by Neighborhood Density by Income				
		Low Inc	M-High Inc	
Density (units/acre)		< \$40K	> \$40K	Total
Low	< 6	3%	22%	26%
Low-Med	6-10	6%	23%	29%
Medium	10-18	13%	12%	25%
High	18-38	9%	5%	14%
V High	38+	5%	2%	7%
Total		36%	64%	100%

Household Income

Downtown LA

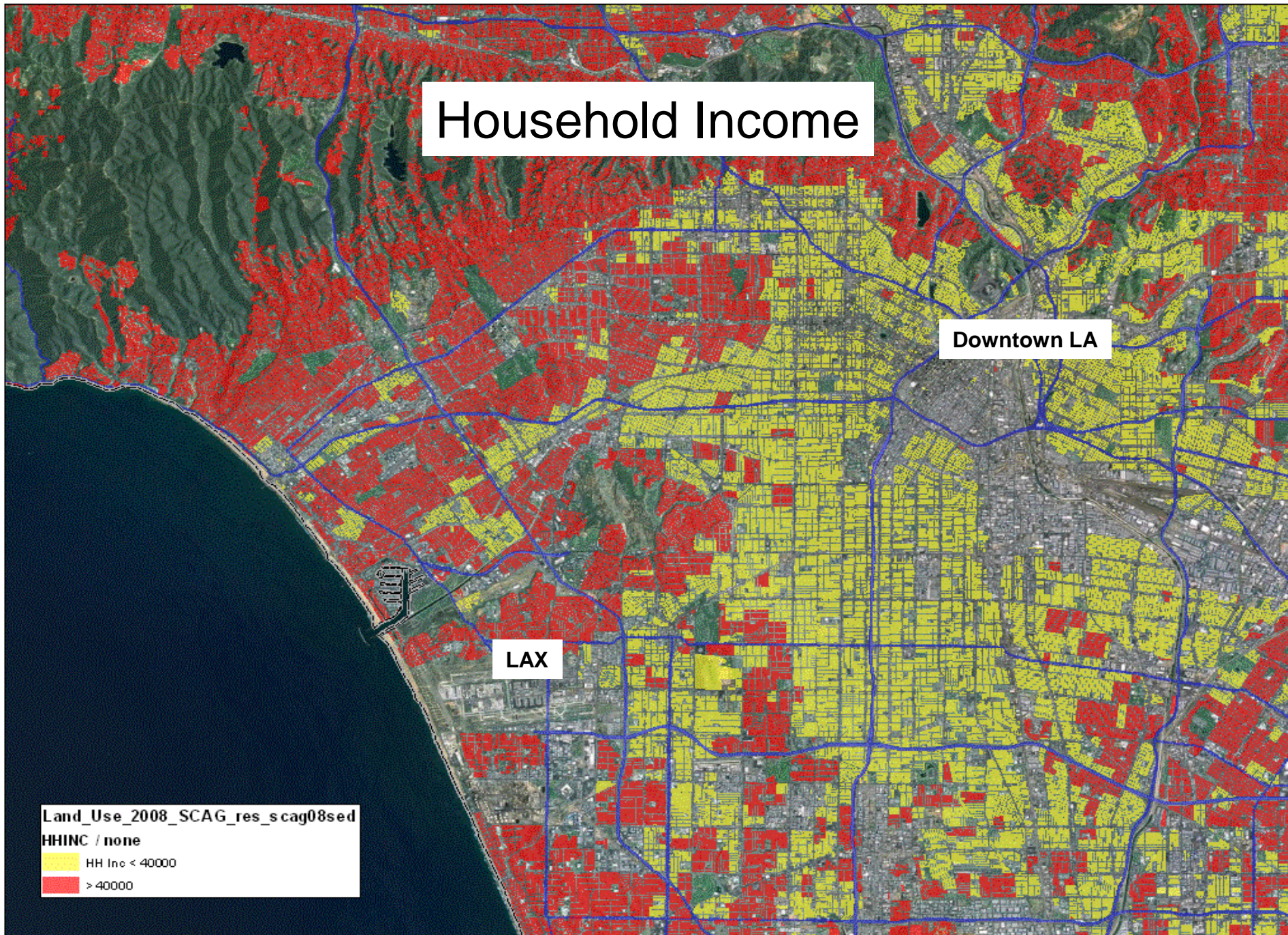
LAX

Land_Use_2008_SCAG_res_scag08sed

HHINC / none

HH Inc < 40000

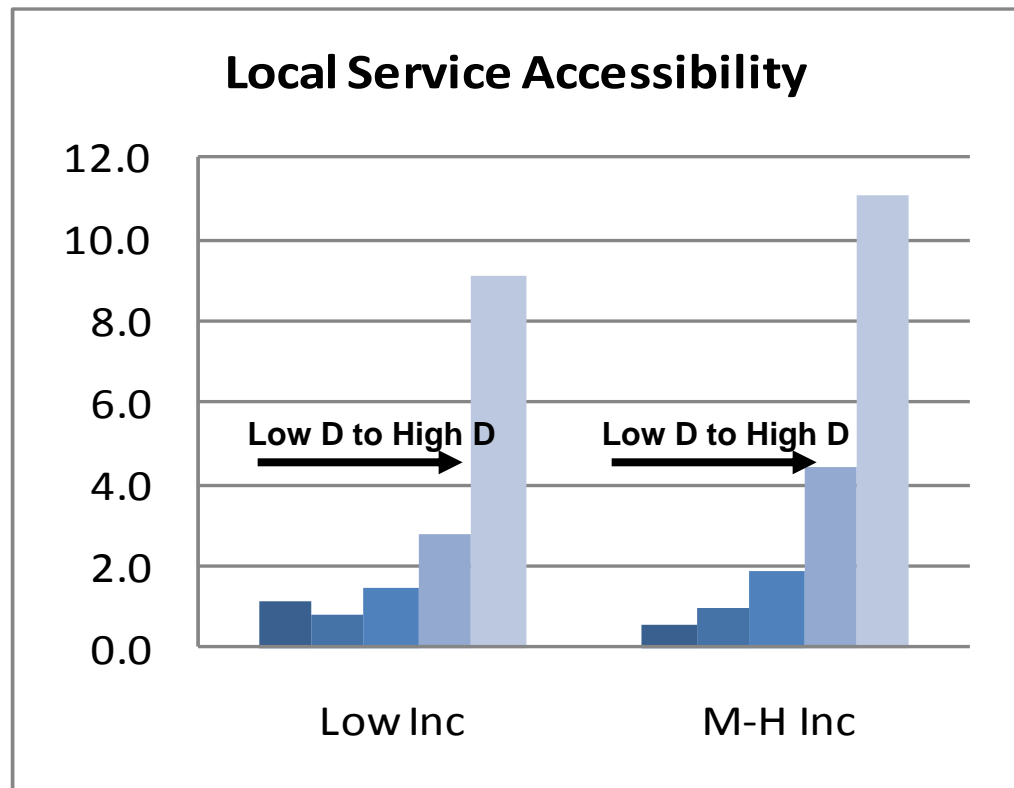
> 40000



Neighborhood Characteristics

Local Service Accessibility

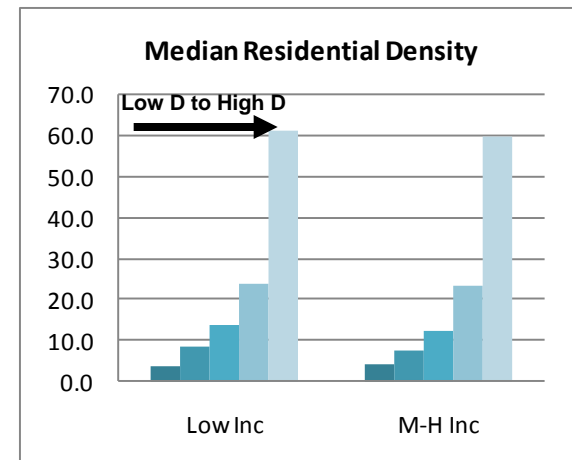
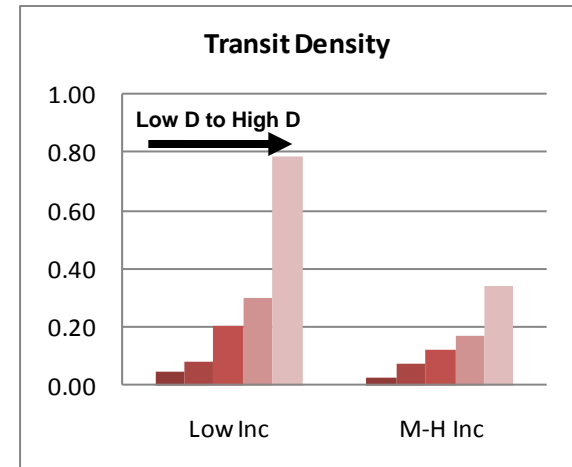
- As density increases, local service accessibility increases
- The pattern between low-income neighborhoods is close to medium-high income neighborhoods



Neighborhood Characteristics

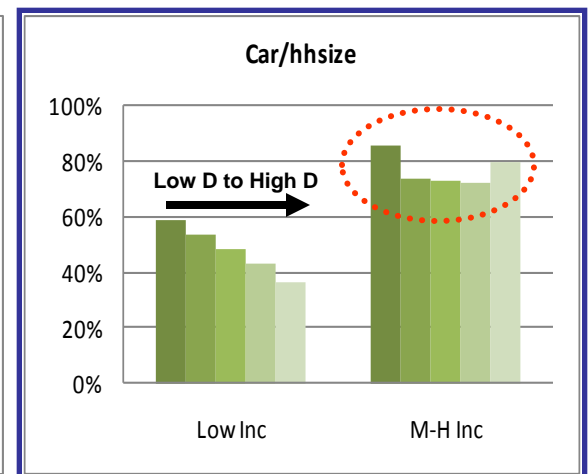
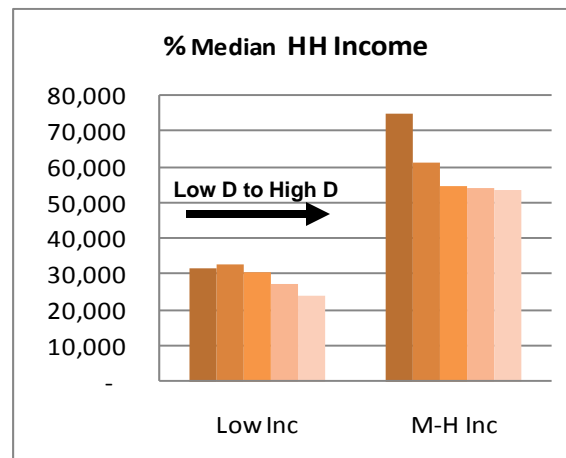
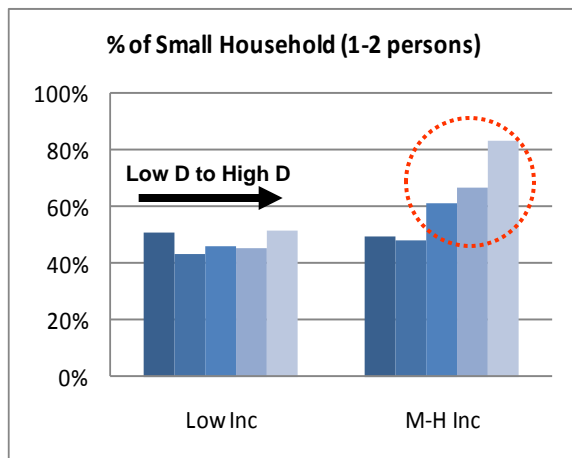
Transit Service and Median Density

- Transit (stop) density increases with higher density. Transit density is the highest for low-income and highest-density neighborhoods.
- Median density is about the same between low-income and med-high income neighborhoods
- Neighborhood characteristics between the two income levels are close to each other



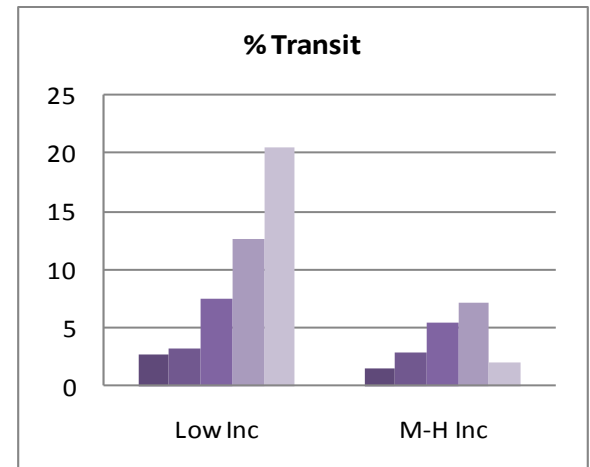
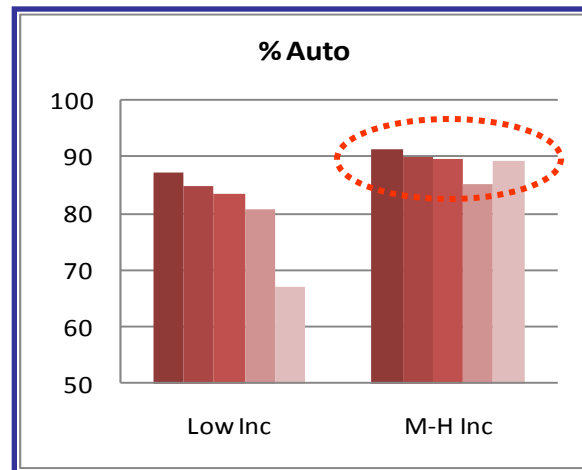
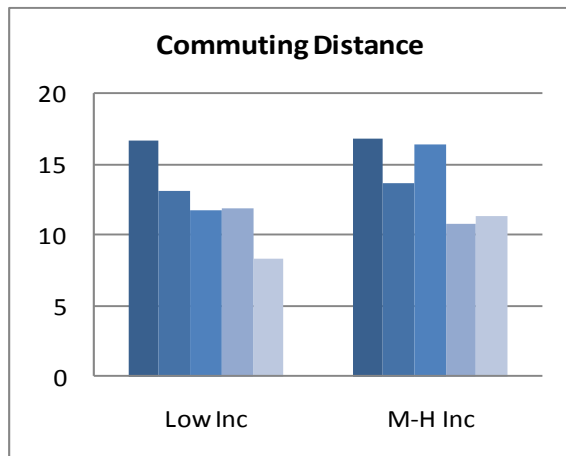
Household Characteristics

- More small households (1-2 persons) for people living in med-high income and higher-density neighborhoods. Is this related to their life cycle status (single, no children, high income)?
- Residential density has no significant association with car ownership for residents in med-high income neighborhoods



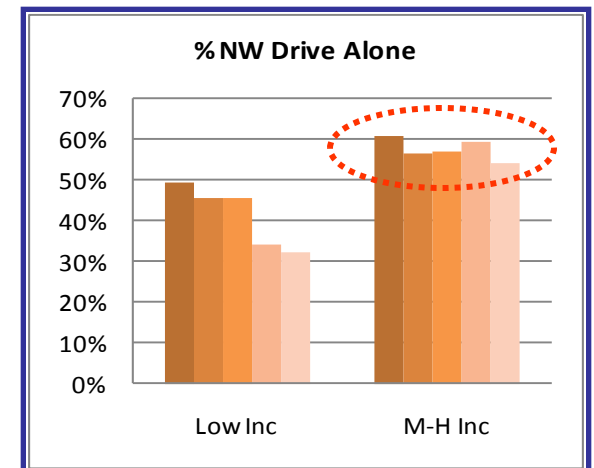
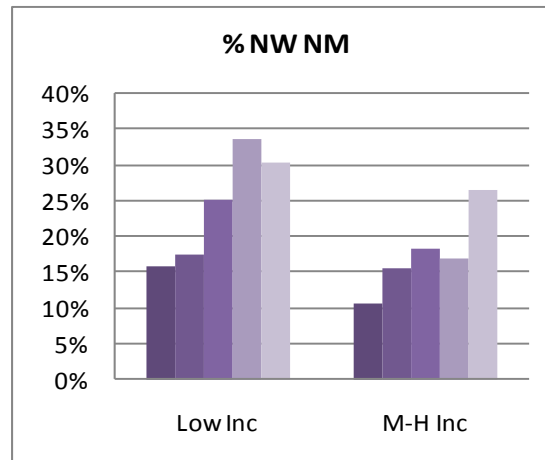
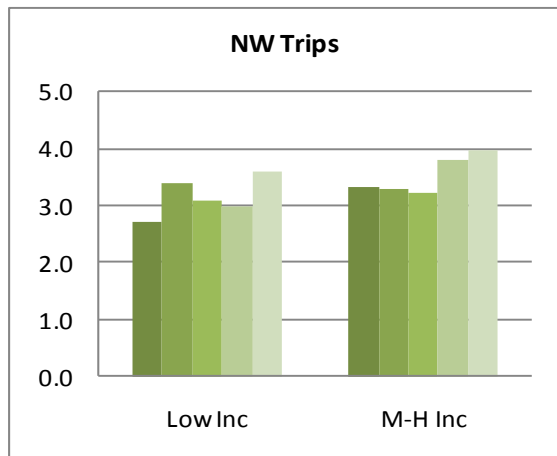
Commuting Distance and Mode

- Overall, commuting distance decreases with density. People do live closer to work location while living high-density neighborhoods
- In low-income neighborhoods, as density increases, people drive less and use more transit for their commute
- For people living in med-high income neighborhoods, density has no significant effect on reducing auto use for commuting purpose. And transit use is quite limited.



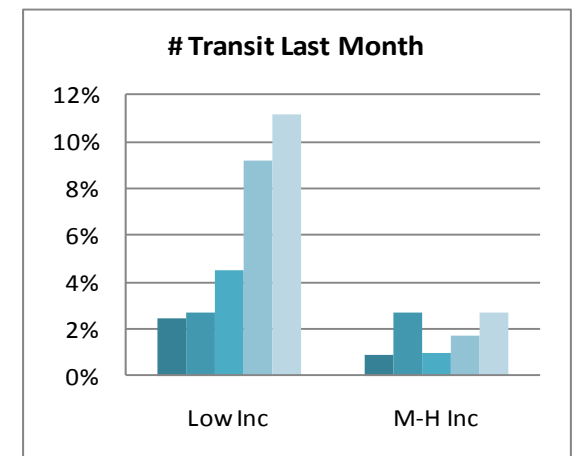
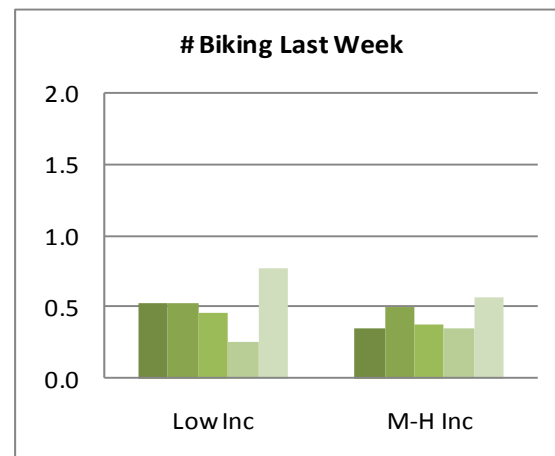
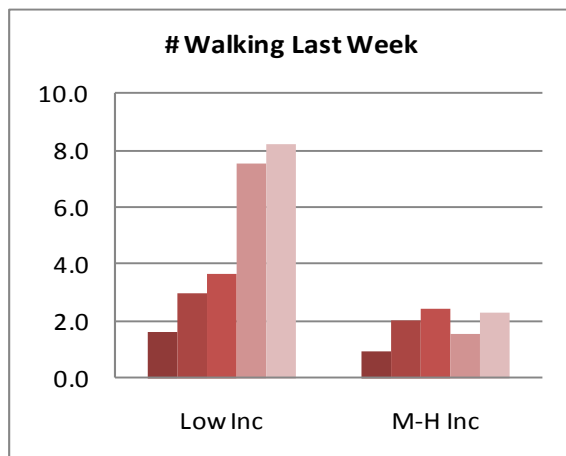
Non-Work Travel

- Generally speaking, people in higher density make more trips.
- Non-motorized share somehow increases with higher density
- Residential density has no significant association with non-work driving for those who live in med-high income neighborhoods



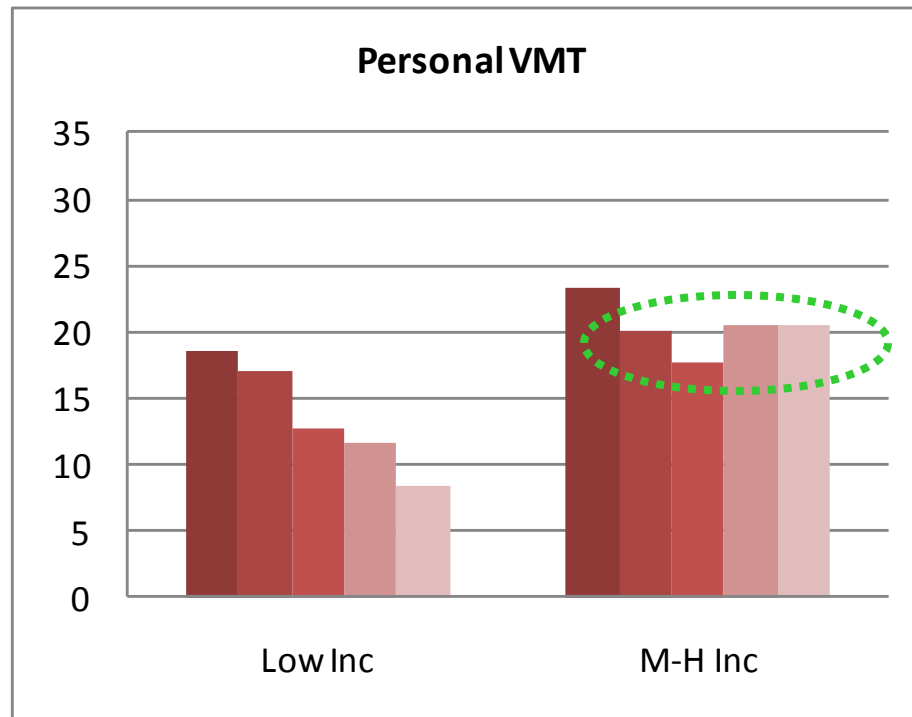
Non-Motorized & Transit

- Will people living in higher-density are more likely to travel more by non-motorized modes or transit? We use NHTS data regarding the number of walk/bike trips last week, and transit trips last month.
- Walk and Transit: Yes to low-income neighborhoods
- Others: Not clear, may need more data
- Density has no clear effect on walking/biking/transit use for people living in med-high income neighborhoods



Personal Vehicle Miles of Travel

- For residents of lower income neighborhoods, personal VMT decreases with higher density
- For residents of higher income neighborhoods, personal VMT is about the same for residential density > 6 units/acre



Travel by Income and Density

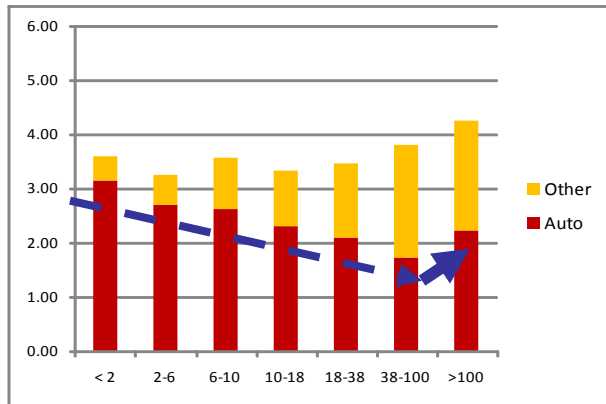
- We conducted one more test to examine whether people with the same income level will travel differently with different land use density
- Data: persons older than 16 years old, with three levels of household income: low (< \$30K), medium (\$30-\$75K), and high (> \$75K)
- Seven levels of residential density
<2, 2-6, 6-10, 10-18, 18-38, 38-100, 100+

% persons with 16 years or older by density										
Income	\Density	< 2	2-6	6-10	10-18	18-38	38-100	>100	Sum	% Income
Low	< 30K	3%	12%	27%	28%	21%	6%	3%	4,230,728	33%
Med	30-75K	4%	24%	34%	27%	12%	4%	1%	4,516,679	35%
High	75K+	5%	31%	32%	18%	7%	2%	1%	3,995,099	31%
% Density		12%	67%	94%	73%	39%	13%	4%	12,740,000	100%

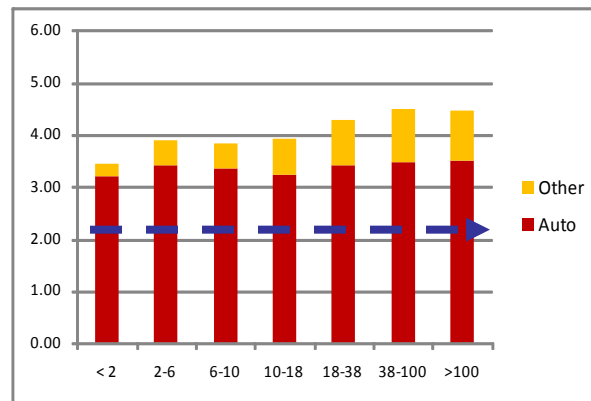
Finding on Auto Use

- For low-income residents, daily auto trips reduces with higher density; for both medium- and high- income residents, auto trips do not have significant drop with higher density.
- Trip made by non-auto modes show more significant pattern to lower-income people. Same pattern for total trips.
- This result is consistent with earlier finding: density has more clear association with auto use for lower-income people

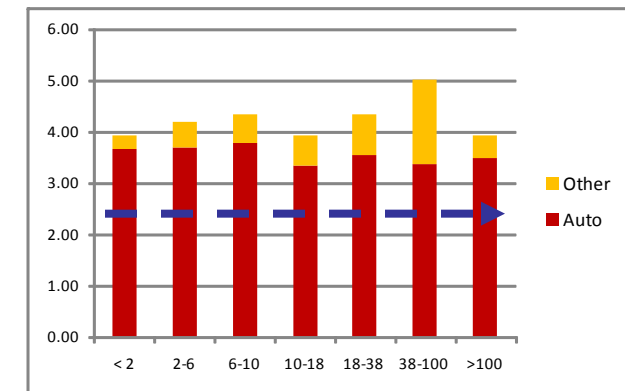
Persons in Low Inc HH (<30K)



Persons in Med Inc HH (30-75K)



Persons in High Inc HH (>75K)

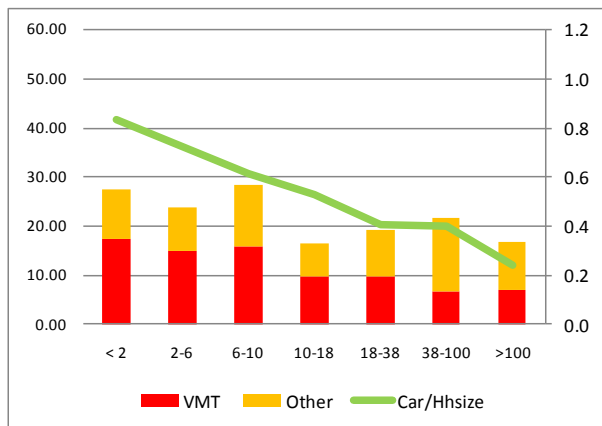


* Persons > 16 years old

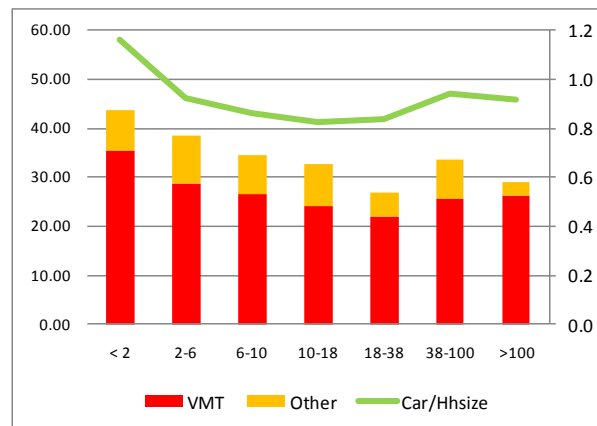
Finding on Travel Distance

- To low-income residents, car is less available to household member with higher density, so does VMT.
- To medium- and high-income residents, VMT does not have significant difference for residential density > 6 units/acre
- To high-income residents, total travel distance increases with higher density
- Density has more clear association with VMT for lower-income people

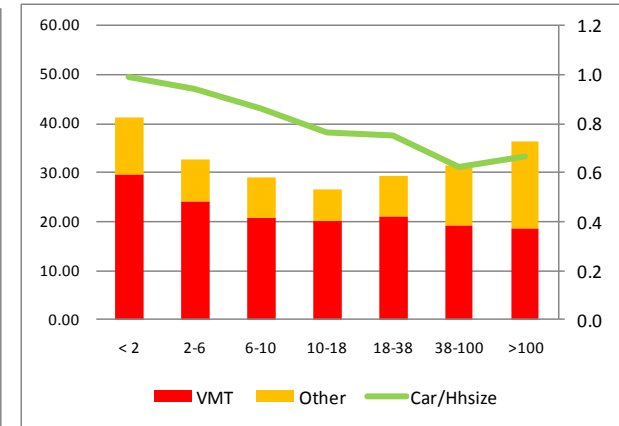
Persons in Low Inc HH (<30K)



Persons in Med Inc HH (30-75K)



Persons in High Inc HH (>75K)

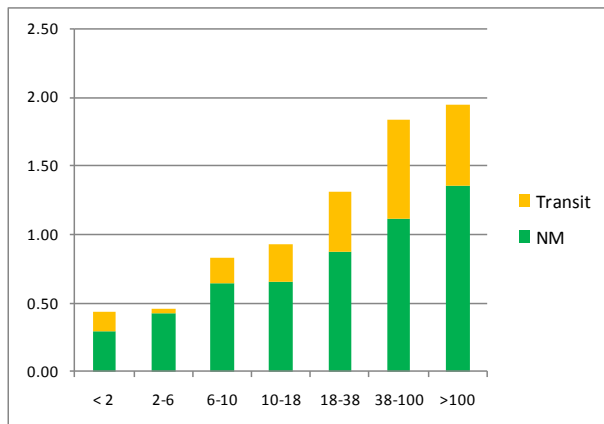


* Persons > 16 years old

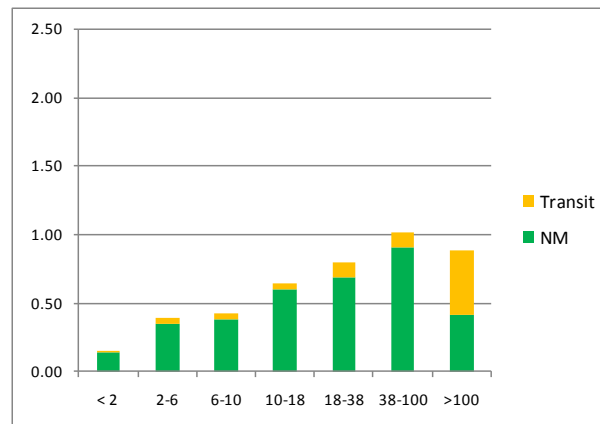
Non-Auto Trips by Income and Density

- In general, as residential density increases, non-motorized trips increase. This pattern is more clear to low-income people.
- Transit trips show significant increase with higher density, especially to low-income people.
- The drastic change of non-motorized trips to medium- and high-income residents living in highest density needs to be reviewed.

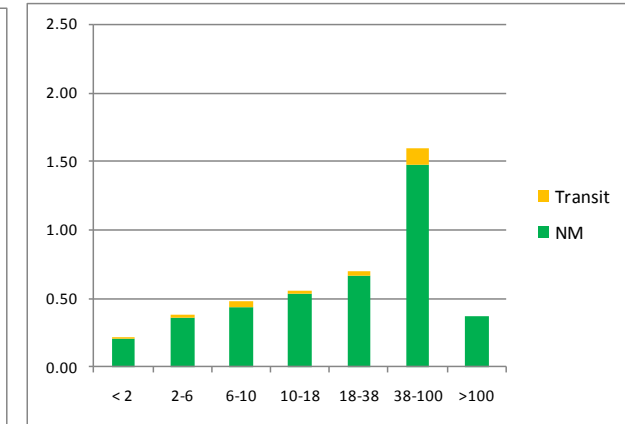
Persons in Low Inc HH (<30K)



Persons in Med Inc HH (30-75K)



Persons in High Inc HH (>75K)



* Persons > 16 years old

Summary

- For low-income residents, as their neighborhood density increases, their work location is closer to home. They tend to drive less, walk more, and use more transit.
- Higher-income residents show different pattern. Generally speaking, residential density has less significant association with their travel behavior. They do not drive less or use more transit as they live in higher-density neighborhoods.
- People with higher income have more choices to capability to make travel decision.
- Land use policies that promote higher density development to reduce car use as well as greenhouse emission should be further reviewed by different demographic characteristics.

Thank you